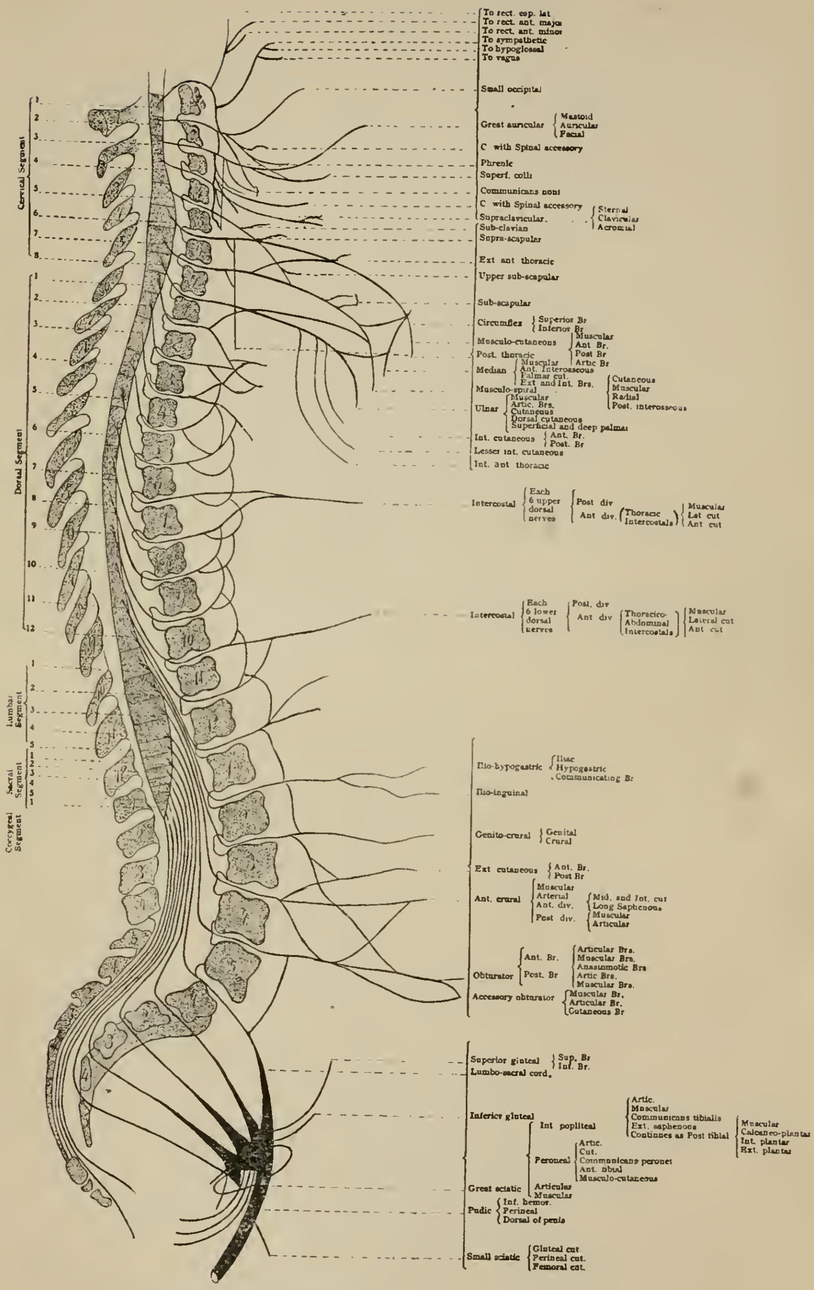

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PLATE I.—The Relation of the Segments of the Spinal Cord and of their Nerve Roots to the Vertebræ.

MECHANICAL VIBRATION

ITS PHYSIOLOGICAL APPLICATION IN THERAPEUTICS

By

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TO ONE WHO LIVES THAT THE WORLD MAY BE BETTER FOR HIS HAVING LIVED,—DEVOTED TO GOD AND MAN.

TO

WILLIAM BENHAM SNOW, M. D.

THIS BOOK IS

AFFECTIONATELY DEDICATED.

MECHANICAL VIBRATION. ITS PHYSIOLOGICAL APPLICATION IN THERAPEUTICS

PREFACE

During the past decade the attention of both the profession and the laity has been directed to drugless therapy, in consequence of which each year sees an advance in physical therapeutics, one of the most valuable agents of which is *mechanical vibration.*

It has an extensive field of therapeutic application of which spinal stimulation and inhibition constitute no small part. In the hands of a skilled operator it relieves patients who would otherwise fall into the hands of medical faddists and fakirs, who succeed in obtaining a clientele for two reasons—first because they employ drugless methods, which the laity are demanding, and second because they have sometimes effected cures,—which can be accomplished much more promptly and thoroughly in the hands of a scientific physician who understands physical therapeutics. Its use is indicated in only a particular class of cases, those which give massage and osteopathy their prestige.

This work is written to call attention to the fundamental principles of mechanical vibration, the understanding of which enhances its therapeutics not only in the present knowledge of the subject, but looking to the important field which will be opened to it in the future.

Mechanical vibration used as a spinal therapeutic agent fills a wonderful field in spondylotherapy as

developed by Dr. Albert Abrams. A chapter is devoted to the employment of mechanical vibration in diagnosis.

It must soon also be recognized as another valuable means for the treatment of high blood pressure and its accompanying symptoms, as well as for the relief of other cardio-vascular conditions. The treatment of these conditions has been made an important feature of this work.

Tables to assist the busy practitioner in the study and diagnosis of nerve and muscle affections have been compiled which are as complete as modern investigation has made possible.

Courtesies are acknowledged from Drs. Sajous, Abrams, Butler, Bassler and Cyriax, and in the use of plates from D. Appleton & Co., W. B. Saunders Co., Macmillan & Co., F. A. Davis Co., and P. Blakiston's Son & Co.

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CHAPTER I

History and Development of Mechanical Vibration Therapy

Mechanical vibration or vibra-massage which has become generally recognized by the profession, is the outgrowth of a subject which dates back to ancient times,—one which has been maturing for centuries, and which has been practiced by many nationalities in various ways, to wit, *massage.* Until recently, however, massage has not received the recognition it so richly deserves, for in the hands of charlatans and quacks—non-professional masseurs—it has principally become known, and not favorably known. It required such men as Mezger, Zabludowski, Bunge, Graham, Seguin, Weir-Mitchell, Playfair, and Kellogg to give it scientific recognition and establish a technique that could be therapeutically employed.

The history of mechanical vibration is brief, but as much can be learned from its development in its relation to massage it is well to consider it in that connection.

The word massage is from the Greek μασσω. to knead; Sanskrit, Masch, to strike to press, to condense, and according to Graham,* includes "friction, kneading, manipulating, rolling, and percussion of the external tissues of the body in a variety of ways, either with a curative, palliative, or hygienic object in view." Friction, rolling, a form of deep

* Graham Massage. Reference Handbook of the Medical Sciences.

kneading, and percussion, are produced by the action of many of the mechanical vibratodes.

According to the Swedish movement cure, massage should be combined with various forms of exercise suited to the case—passive, assistive, resistive, or active movements. Such combination with vibration greatly enhances its field of usefulness, and increases its therapeutic value. It is believed that the "Shoshruta" of the Hindoos, used also by the Brahmins, is the oldest work on the subject. It was probably followed later by the Chinese book, Cong-Fou of the Tao-Sse which was written hundreds of years before Christ. Some believe that the Greeks probably got their knowledge from the Hindoos and Chinese.

Homer, about 1000 B. C., in his masterpiece, the "Odyssey," notes that rubbing and anointing were used for their invigorating effects. The ancient Greeks and Romans of all classes used massage as a luxury, to hasten recovery from sickness, or to increase their agility and powers of endurance. After gymnastic exercises, it was used in the treatment of pains and as an invigorator, marking its early recognition as a therapeutic agent.

Its place, however, today can be far more ably filled by properly applied mechanical vibration, due regard being given to rate, stroke, mode of application, and applied technique. At that time, it was in the hands of priests, trainers (aliptae), and slaves as well as medical men. This is one reason for the slow development of scientific massage. When a subject is taken up by a body of learned men, investigation is thorough, improvements are suggested, and progress results, but when it falls into the hands of charlatans and quacks, the avenue of progress is blocked. For

this reason mechanical vibration as a science did not develop until massage had been established on a physiological and well defined basis.

In the 5th century Herodicus advocated exercise for the treatment of disease and compelled his patients to have their bodies rubbed, he being a firm believer in the efficacy of massage.

Joseph Schreiber, M. D., author of "Treatment of Massage and Exercise," translated by Walter Mendelson, M. D., of New York, claims that Herodicus "first laid down principles for rational, mechanical methods of treatment."

Herodotus, 484 B. C., was one of the first to refer to the *manner* of giving massage. He said friction should be gentle and slow at first, then rapid in combination with pressure, which was to be followed by gentle friction. Other advocates were Plato, Socrates, and Hippocrates, who said "rubbing can bind a joint that is too loose, and loosen a joint that is too rigid. Hard rubbing binds, soft rubbing loosens, much rubbing causes parts to waste, moderate rubbing makes them grow." This is the earliest definite information relative to the effect of variations in the application of massage. These maxims should be remembered by those who use mechanical vibration for they well define its general therapeutic application. Hippocrates also suggested the *direction* in which to apply massage, the art of rubbing up, thereby assisting mechanical and physical processes, aiding circulation, relieving stasis and consequently quickening metabolic processes.

Asclepiades, 128-56 B. C., used massage in conjunction with active and passive movements. Cicero and Julius Cæsar were also advocates, the latter even

allowing himself to be pinched daily as a treatment for neuralgia.

Celsus believed most firmly in rubbing, advocating it for chronic pains of the head and for strengthening a paralyzed part. He mentions *general treatment* and also speaks of *localization,* but adds that sometimes treatment is necessary in a part *other than the seat of pain* which is along the same line of thought as vibratory treatment applied to " referred pain." He also mentioned the *length* of treatment, saying that a general treatment if weakness be present should be shorter and gentler than a local treatment—an important consideration in vibratory treatment.

Hadrian, Pliny, and Martialis were also earnest advocates of massage. Galen, A. D. 130-200, recognized friction usually as an adjunct to other measures. He said that if friction be used before exercise for the purpose of rendering the parts supple and less liable to injury, "*the middle quality between hard and soft*" should be used, and this is the keynote to mechanical stimulation. Even at that early date there were advocates of various modes of rubbing. Some taught that tranverse rubbing, known as " circular rubbing, hardens, and condenses and contracts, and binds the body, but that perpendicular rubbing rarifies and dilates, and softens and unbinds." Galen, however, was eclectic in his views and favored variations in application, advocating nine different ways of employing massage.

Arrian advised *stretching* in connection with massage, which in conjunction with relaxation induced activity of the lymph current. This should be borne in mind when using mechanical vibration, particu-

larly when treating local stasis. Stretching is also useful when applied to affections in which it is desirable to increase the joint nutrition.

ORIBASIUS, a Greek, speaks of the "apotherapeia," a method which included bathing, friction, and inunction. A new feature mentioned by him was that of extension and holding the breath. Extension assists also in the treatment of selected cases when using mechanical vibration; for example, in tendosynovitis. The patient should not hold his breath during a vibratory treatment, but take deep inhalations followed by slowly forced exhalations. This enables the operator to administer deeper vibratory treatment over deep structures, as the solar plexus, and is a great assistance when giving passive exercise as an adjunct to vibration. Greater tension can be made during the period of forced exhalation.

AN ANCIENT METHOD mentioned by Blumenthal was one used by the Greeks, which consisted of wrapping one end of a saw in cotton fabric and applying it to the part to be treated while on the uncovered part of the saw a piece of wood was sawed; thus mechanical vibration was transmitted to the part requiring treatment.

THE SCOURGE was also used in cases of impotence. The back was rubbed to cure sterility in ancient times, and "Roman ladies allowed themselves to be whipped with strips of leather" for the cure of the same condition.

PARACELSUS, 1492-1541 A. D., Professor of Surgery at Basle, in 1526 wrote "Liber de Vita Longa," in which the effects of friction are extolled, indicating the early recognition of its therapeutic value.

In the sixteenth century, a Japanese book, " Sau-Tsai-Tou-Hoei," demonstrated the use of *percussion, vibration,* and *pressure,* as well as *passive motion.* These methods were used by the Japs for many years. They were applied for relaxing " rigid muscles " and spasmodic contractions, for the relief of rheumatic pains, and after the union of fractures, conditions amenable to mechanical vibratory treatment.

AMBROISE PARE, 1517-1590 A. D., noted for introducing the ligation of arteries, described and advocated that three modifications of friction—gentle, medium, and vigorous—be employed, and demonstrated the effects of each, showing that some attention was then given to technique and its results.

IN 1573, MERCURIALIS published " De Arte Gymnastica," treating of the beneficial effects of movements. Fabricius ab Aquapendente of Padua, author of " De Motu Locali Secundum Totum," Guyon, author of " Miroir de la Beuté," Sydenham, and Hoffman, who wrote " Dissertationes Physico Medical " in 1708, believed in massage. Francis Fuller in 1740 wrote " Medical Gymnastique " in which he treated of the " influence of motion " and its therapeutic value. *Flagellation, percussion* and *slapping* were prescribed in the seventeenth century by Paullini. Massage rollers and muscle beaters applied in many ways by changing their shapes were primitive vibrators.

ABBE ST. PIERRE, in the early part of the eighteenth century, invented the trémoussoir.

Three systems relative to motion followed the mediæval period: the Stahl or iatro-mechanical, the

Boerhaave or iatro-dynamical, and Hoffman's or the mechanico-dynamical.

An old book of special interest to the mechanotherapist is "A Full Account of the System of Friction as Adopted and Pursued with the Greatest Success in Cases of Contracted Joints and Lameness from Various Causes" by John Grosvenor, the celebrated English surgeon. He did not consider it a cure-all. He said it was not applicable "in all cases of inflammation, in scrofulous cases tending to suppuration, in cases of inflammatory gout and rheumatism" and was "useless in cases of true ankylosis." He found it valuable in "contractions of the joints attended with languid circulation, and thickening of the ligaments," where there was "too great secretion of the synovial fluid in the joints, after wounds in ligamentous, tendinous or muscular parts when the function of the limb is impaired; after violent strains of the joints; in incipient cases of white swelling; after fractures of the articulating extremities of the joints when stiffness remains after union; in cases of dislocation of the joint when the motion is impaired some time after reduction; in case of paralysis; in case of chorea combined with attention to the system; and in weakly people where the circulation is languid." His selection of cases was certainly apt, and the line of division will follow about the same course when mechanical vibration is used, particularly vibratory friction.

In 1808, John Barclay wrote "The Muscular Motion of the Human Body" in which he relates a case of muscular contraction cured by *percussion* alone. M. Blache in a paper on chorea treated by mechanical means, opened the eyes of the profession

in France, but Ling and Mezger probably gave the most marked impetus to the subject.

In the early part of the nineteenth century, William Balfour wrote on "Illustrations of the Power of Compression and Percussion in the Cure of Rheumatism, Gout and Debility of the Extremities, and in Promoting Health and Longevity." He says that "Medical practitioners encourage their patients in giving perfect rest to parts affected with rheumatism and gout, till, as often happens, they change their action altogether." He claimed in respect to the treatment of gout by percussion that "percussion, instead of repelling, creates an afflux of nervous energy and sanguineous fluid to the part. Vessels in a state of atony are thereby roused to action and circulation is promoted; and bandages support the vessels and enable them to perform their functions." This was an attempt at an explanation of the physiological action of percussion, so necessary to thoroughly understand that percussion may be more intelligently used therapeutically.

In the nineteenth century impetus was given to the subject by Ling's "Swedish Movement Cure" which took note of the association of organic disturbances with tenderness of special spinal areas. The Griffins associated symptoms with tenderness of definite spinal areas. Hall's work called attention to spinal reflexes. The osteopath believes that diseased organs cause spinal tenderness which may be relieved by manipulations to remove pressure due to displaced vertebrae.

In the middle of the nineteenth century, Zander constructed mechanical motion devices, as his "Headshakes" for neuralgia, etc., and still later

Vigoreaux employed a tuning fork in connection with a resounding box for the treatment of contractures, locomotor ataxia, etc.

TAYLOR OF NEW YORK AND KELLOGG OF MICHIGAN were also among the pioneer inventors and users of mechanical apparatus for massage. Vibrating, shaking, rolling, percussion, compression, and friction can well be done by such apparatus but due regard to careful technique is necessary in their successful manipulation, as much so as in manual massage. The majority of this apparatus vibrated the subject *en masse.* The next advance step was the introduction of vibration apparatus by means of which treatments could be more localized, the apparatus better controlled, and capable of being applied with a greater nicety of technique.

Peoples of warm countries and cold countries, barbarous and civilized alike, have methods of massage, manual or mechanical. The Toogi-Toogi, Mili or Tota of the people of Oceanica described by Graham comprises " striking constantly and softly with the fist, rubbing the palm of the hand, and pressing and squeezing the tissues between the fingers and the thumb." It illustrates combination of effects that can be produced with a vibratode. The natives used it for fatigue, pain, etc., and curiously enough, if for fatigue, treated only the arms and legs, but if for pain the surrounding area of the particular site was treated, demonstrating that they had an idea of localizing treatment. The Sandwich Islanders use a mixture of kneading, squeezing, and rubbing called lomi-lomi.

DURING THE TWENTIETH CENTURY the advancement of the status of exercise by such men as Savage, Kel-

logg and Sargent, has aided also in advancing massage. Dr. Joseph Schreiber considers that the first treatise on mechanical manipulation, physiologically considered, " appeared in 1876 by von Mosengeil in Archiv fur Clinische Chirurgie." He put it on a scientific basis.

Others adopted it, and now through Cyriax's study and application of manual vibrations and frictions, Abrams' study of spinal therapeutics, Schmidt's study of pain, and Sajous' study of disease, mechanical vibration may be applied more scientifically.

Massage to-day is of three types—massage as used scientifically in connection with drugs or physical therapeutics as exercise, hydrotherapy and electricity; massage in the school of osteopathy, which virtually massages and moves joints for the action on nerve centers; and the unfavorably known massage of the charlatan.

Eventually, massage as a therapeutic measure will be better systematized. Mechanical vibration should profit by past experience and beginning with the present status of scientific manual massage, build up scientifically, physiologically, and therapeutically. This must not be done from the mechanical aspect of the subject alone, for not until exercise was placed on a solid physiological basis did it advance, and not until mechanical vibration is studied from a standpoint other than that of empiricism and the commercialism of the manufacturer will it obtain due recognition from the medical profession.

By recognizing the modes of massage we can more clearly see its relation to mechanical vibration.

" Slow and gentle stroking in a centripetal direction is called effleurage, deep rubbing is massage à

friction, deep manipulation without friction is pétrissage," and percussion, one of the main features of mechanical vibration, is tapotement. Dr. Graham* makes the subdivisions of " friction, percussion, pressure and movement," and recommends that " all of the single or combined procedures should at first be used *moderately, then gradually increased in force and frequency* to the fullest extent desirable, and end gradually as begun." He states the dose is "*determined by the force and frequency* of the manipulations and the *length of time* during which they are employed considered with regard to their effect upon the patient," which technique is applicable to vibration therapy.

The application of manual vibration to the human body therapeutically has been known for many years. Ling and his advocates had an idea of this mode of treatment of the nerves, and organs, and of its results, as noted in " Georgii Traitement des Maladies par le Mouvement," Paris, 1847.—" They observed the effective influences travelling from front to back in the direction of the sinus longitudinalis and of the sinus transversalis, and applied, therefore, vibrations successfully in congestion of the brain. Heinrich Kellgren developed this method about twenty years ago. He improved the Ling system and added new features. "As an example of the new manipulations may be quoted nerve frictions and vibrations, by means of which he was able to treat with remarkable success diseases of the central nervous system, etc., and which, in his hands formed a powerful weapon to combat acute specific infectious diseases." The great value of manual vibration was

* Graham Massage. Reference Handbook of Medical Sciences.

recognized and probably first demonstrated in this country by Dr. Strensch, who introduced his method in 1891. Cyriax's studies and work, "The Elements of Kellgren's Manual Treatment" which includes manual vibration is of importance. Abram's "Spondylotherapy" represents probably the most exhaustive thought on spinal therapeutics.

Among other contributors are Meltzer, Tomson, Charcot, Liedbeck, Boudet, Tourette, Godman, Morselli, Garnault, Granville, Lavalette, Reich, Taylor, Monell, Lucy Hall-Brown, Morse, Wallian, Eberhardt, Gottschalk, Saquet, Bechterew and Tschigajew, Vigorcaux, Axenfeld, Lange, Winternitz, Siegfried, Bjǒksten, Colombo, Ledermann, Hasebrock and Ewer.

It is curious to note that France, the slowest country to adopt massage and yet the one that gave it its name, is the European country that has most extensively employed mechanical devices for vibration-therapy, and as a nation has furnished the most prolific writings on the great sub-division, vibramassage, except possibly the United States.

The subject of vibration is growing in favor and embraces not only that of manual and mechanical vibration, but chemical, thermal, and electrical.

The word vibration* means "*a recurrent change of position.*" *Vibrations are movements where the recurrent changes of position occurring at equal intervals of time called periods of vibration, which may be infinitesimally short, or of sufficient duration to be noted in time, give them the character of waves whose amplitude is very small. Periods of vibration* must not be confused with *duration of vibrating*

*Gage. Elements of Physics.

state relating to the whole. The *amplitude* of the vibration may vary or be fixed in any given apparatus, and the vibratory movement may be *simple* as with the pendulum of a clock, or in the unrestricted movement of an ordinary vibratode, or *complex* as when the vibratode has not a full swing; for example, when it meets the resisting surface of the body of the patient. The hand may be the motor, or the power may be liquid air, carbonic acid gas, electricity or water.

Etheric vibration induced by chemical substances is of greatest intensity, as produced by radium and other radio-active substances, thorium, polonium, uranium, and actinium. These substances give off ether vibrations without stimulation from any known source of energy, setting gases in vibration, producing varied spectra. There are three kinds of rays emanating from radium graduated according to their vibratory activity, as α, β and γ, the γ resembling the X-rays, the β rays of higher vibration resembling the cathode rays, which are of still higher vibratory rate, thereby giving " a more powerful chemical action and profounder physiological effects," and the α rays of still higher vibratory rate.

Etheric vibration induced by electric power is of wide range from the vibrations produced by the continuous and induced current batteries to those of the static machine, or coil; varying also from the convective discharges including static electrification, interrupted or constant, the breeze, spray, brush discharge, and high-frequency discharges from the glass vacuum tubes, to the conductive discharges including the static induced current and the wave-cur-

rent and also the X-rays, as well as the rays produced by modern photo-therapeutic apparatus.

SELECTIVE, HARMONIC, ELECTRIC VIBRATION, another form or modification of vibration, has recently been scientifically presented by Morris W. Brinkmann, A. B., M. D., of New York. He considers simple and compound vibrations, but subdivides the simple into slow, moderate and high-frequency, and the multiple into combinations of simple rates, harmoniously or discordantly, and " combination of multiple rates from single blows, 16 to 40000 per second or any multiple rates above this to infinity." Pitch, intensity, and timbre are characteristic qualities valuable in therapeutics and are closely associated with the physics of sound. As it is known that hearing depends upon the physiological condition of the organ of Corti, and the optic nerve, and as hearing varies, so do other parts respond differently as their pathological or physiological conditions vary. Dr. Brinkmann says that the body " attunes itself " to rates below 16 per second, which the ear does not hear, and " general sensation is influenced." He believes that the " sensory apparatus and muscle sense can estimate and adapt themselves to 3000 vibrations per minute." Thickness, tension, and length he says, may regulate " the particular rate or note to which a muscle, nerve or other tissue " may be attuned or respond. The theory is that for example, in a striped muscle composed of fibres which are made up of fibrillae of different lengths and tensions, "the concurrent use of several rates of oscillation " is required. He therefore believed that harmonics would be more useful than single notes, and devised an apparatus which will be considered later.

This subject in a simple form was recognized by Dr. George H. Taylor and Dr. H. C. Houghton, of New York, and Dr. J. Mortimer Granville, of London, a number of years ago. Dr. Granville studied and devised an instrument for musical vibra-massage which is said to give from 1000 to 2000 blows per minute.

The subject of mechano-vibration has been studied by Reich in the "Lexikon der Physikalishen Therapie. Diätetic und Krankenflege." He makes a distinction not as yet recognized in this country, the differentiation of concussion and vibration. Vibration is of higher frequency and a milder form of movement while concussion is stronger with less frequency, the maximum being from 120 to 150 per minute. He regards vibration to be high frequency, and concussion low frequency, the body not having time to come to rest before the second tap comes in the first form, results in the summation of stimuli, but in the second form the body has time to come to rest between two single pushes. He cites the Ewer concussor as a type of an instrument giving concussion but not vibration.

VIBRATION IS A SUBJECT OF WIDE RANGE AND CONCEPT, and a brief sketch of it has been given as a whole in order that when we limit ourselves to one small part—mechanical vibration, vibra-massage, or massage, we may bear in mind particularly the import of knowledge gained from experience in other lines of work, the history of massage as it deals with manner, time, frequency, etc., the consideration of manual vibration, light, heat, and electricity, particularly the static with its most pronounced vibrations, their physiological actions and therapeutic

results, and harmonic vibration with its peculiar selectiveness. Time and energy should not be wasted in trying to build up something entirely new when there is so much that has been authoritatively demonstrated, but use should be made of all that is applicable and reliable from whatsoever source, building thereon scientifically for the advancement of vibration therapy in the interest of suffering humanity.

CHAPTER II

Mechanical Vibration Apparatus

As noted in the previous chapter, mechanical vibration in its application was in the process of development when the Greeks wrapped one end of a saw in cotton and applied it to the part to be treated —while sawing a piece of wood with the uncovered portion for the production of vibration. The improvements on primitive vibrating devices suggested

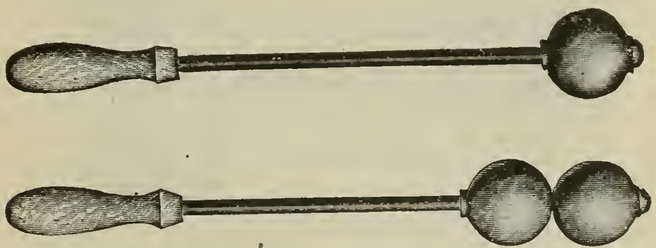


Fig. 1.—Graham's Muscle Beater.

for use with massage were various hand instruments —Klemm's muscle beater, Graham's elastic rods (See Fig. 1) with rubber balls, massage rollers (See Fig. 2)—and later the machines of Zander, Taylor, (See Fig. 3), Kellogg, Charcot, Phelan, Nebel, Herz, Funke and Krukenberg.

There are two forms of Zander machines (See Figs. 4a and 4b), one for massage and the other for movements. " Their operation depends upon various applications of the lever principle. A manometer is so attached as to show or register the force used, the speed of each machine is governed by the

number of teeth in its several cog-wheels, adjustable to obtain differing rates and extents of movements, and a special clutch-wheel or a governing handle is so fitted to each as to make it possible to throw the whole machine out of gear and stop it in an instant."

Necessity is the mother of invention. A demand for means of lessening the laborious task of the masseur and various other factors gave an impetus to an old subject. French, Germans and Americans have accordingly invented and improved the where-

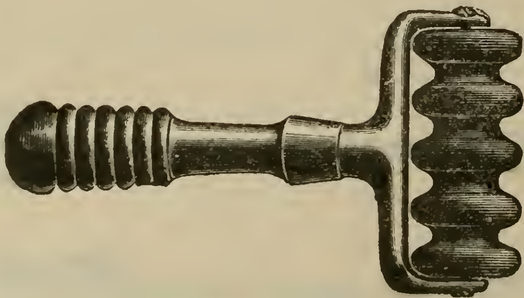


Fig. 2.—Neck Massage Roller.

withal by means of which the work could be better and more easily accomplished by machinery, thereby saving the time, energy and patience of the operator, and enabling him to give treatment with greater precision as to stroke, and definite measurement as to speed. The employment of the apparatus may or may not equal or excel that of manual massage, according to the touch, knowledge, skill and technique of the operator with each, and the adaptability of the apparatus to the particular work in question. The vibrators now on the market are too numerous to mention, and many of them are not practical for therapeutic purposes. The French have probably

contributed more to the literature of the subject of mechanical vibration than any other European nation, and a description of much of their apparatus can be found in the Transactions of the International Congress of Electro-Therapeutics for 1900.

The most powerful vibrators are usually not portable as the motors are too heavy. Only a few of the

Fig. 3.—Taylor Machine—Single Manipulator.

portable vibrators fulfil the requirements of a first class machine. Some vibrators have a flexible shaft, others a rigid arm connected to the motor. Compressed air vibrators use rubber tubing. Most portable vibrators have merely a cord for conducting the current. The device by means of which vibration may be administered is variously designated as applicator, attachment, and vibratode from vibration, vibro, to shake, and σδος, a way.

Vigoreaux used to employ a tuning fork in connection with a sounding box, in the treatment of hemianaesthesia, contractures, pain, etc. Among some of the devices are the vibratory fork of Boudet of Paris, used for anaesthesia and neuralgia, a hand vibrator, Charcot's vibratory helmet, the vibratory cap of Drs. Gilles de la Tourette, Larat and Gautier,

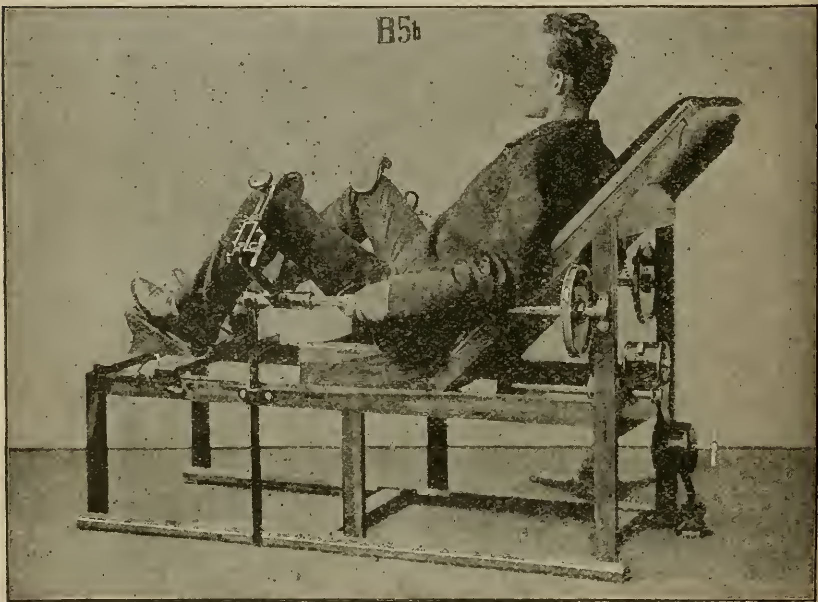


Fig. 4a.—Zander Vibrator Massage Apparatus Showing Method of Operation.

the vibratory handle of Dr. Garnault, and the vibrating table of Drs. Charcot and Gilles de la Tourette, from which the patient received a treatment by sitting in a chair on the vibrating table. Two well known vibrators in use to-day are German inventions. One of the first vibrators introduced into this country from abroad came from Germany. It resembled an oscillator.

Among the small instruments noted is a vibrating urethral sound used by Lankowski, Berlin. It* is "a large metal sound fitted into the rolled end of a wide metal spring, wider and stronger than a watch spring. The end of the spring holding the sound is screwed flat between the narrow metal plates, and fastened together with two thumb screws. The sound

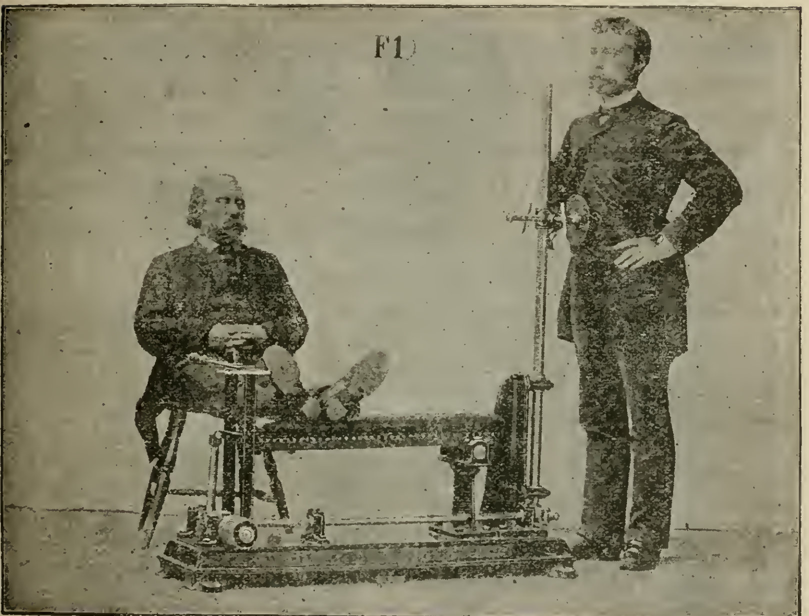


Fig. 4b.—Zander Movement Apparatus Showing Method of Administering Leg Adduction with Resistance.

is inserted in the urethra, and slight blows are struck on the projecting coil of the spring with a padded mallet." The treatment was administered daily or on every second or third day. The largest sound capable of being introduced without causing pain was found to produce the best results. It was used

*Journal of Advanced Therapeutics, June, 1902.

in cases of relaxation, over-stimulation, sexual neurasthenia, phosphaturia and prostatorrhea.

For the administration of mechanical vibration by hand many devices sold in America are used, a few of which are a roller chain, consisting of a double roll of wooden balls, shown in Fig. 5, that revolve in a flexible, jointed, nickel-plated wire chain, having handles; a roller chain and exerciser combined, many

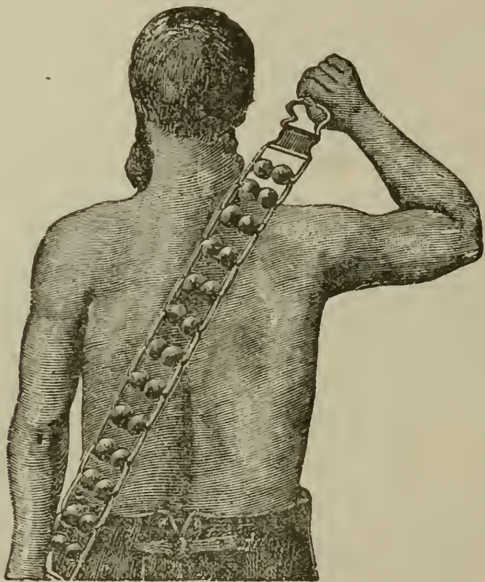


Fig. 5.—Roller Chain.

massage rollers, a Preuss' elastic roller (Fig. 6) with 12 interchangeable balls—4 smooth wooden balls, 4 corrugated wooden balls and 4 soft rubber balls—a neck roller, made of a piece of solid soft rubber corrugated into five prongs, wheel-shaped (Fig. 2), holding a nickel-plated roller of metal; a massage hammer (Fig. 7), with corrugated soft rubber cushions; muscle beaters; a combined roller, kneader and beater (Fig. 8); Graham's muscle beat-

ers (Fig. 1), consisting of rubber balls attached to flexible rods having a handle at one end; Klemm's muscle beater (Fig. 9), with fingers made of "light steel springs," and Japanese massage rollers.

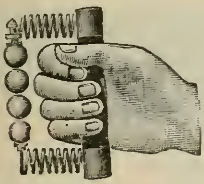


Fig. 6.—Preuss Elastic. Roller.

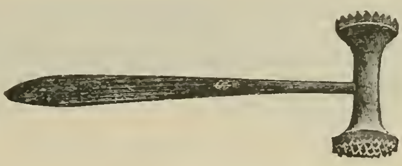


Fig. 7.—Boxwood Massage Hammer.

Concussors for vibratory treatment are of many different shapes and sizes, including probe pointed ones (Fig. 10), for the pharynx; Ewer's disc, designed for the throat (Fig. 11); round knobbed, con-

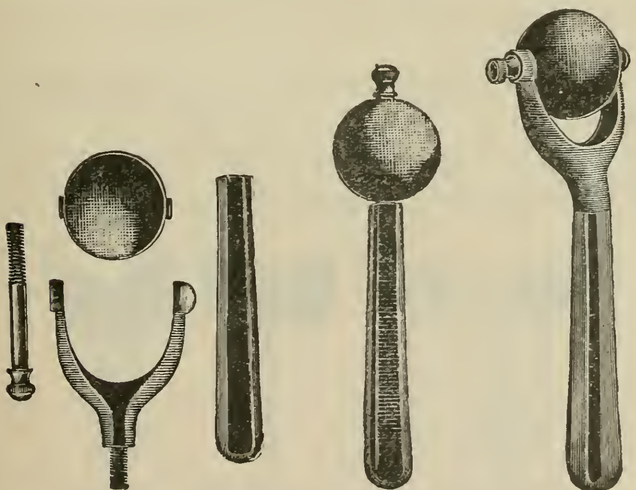


Fig. 8.—Combined Roller, Knea der and Beater.

cave plate, slightly curved, and saddle shaped (Figs. 12, 13, 14 and 15), and Dapper's abdominal plate and disc (Figs. 16 and 17); also concave wheels, cylindrical, corrugated roll and rotation rollers of

various designs. There are also many designs of rotary beaters (Figs. 18 and 19), employed for vibration therapy, some consisting of rubber balls, others

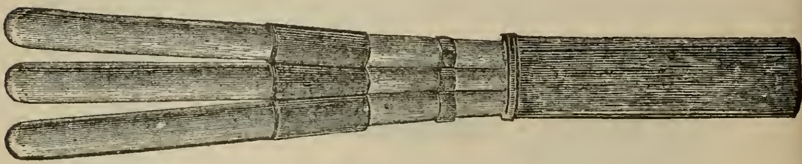


Fig. 9.—Klemm's Muscle Beater.

of leather straps or hammers; others are for tapping massage, such as an instrument with a cylindrical end for vaginal and uterine use; a long leather covered fork for use in neck and throat treatment (Fig.

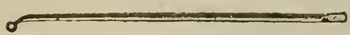


Fig. 10.—Small Probe Pointed Concussor.

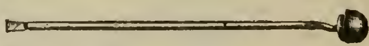


Fig. 11.—Ewer's Disc Concussor for Throat.

20), and a combination rotating and tapping concussor.

A SMALL PORTABLE VIBRATORY APPARATUS, to be operated by hand, is used like forceps (Fig. 21).

Fig. 12. Fig. 13. Fig. 14. Fig. 15.
Ewer's Concussors for Vibration Massage.

" By opening and shutting two vibration exciters (hammers) are set in alternating motion." The operator can vary the speed " from 12 to 1500 vibrations per minute."

Another example of a small portable apparatus is one provided with a vibrating fork, (Fig. 22), operated by dry cell batteries and said to give from 500 to 5000 strokes per minute.

Fig. 16.

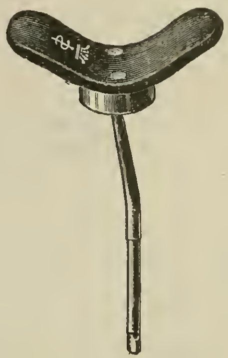


Fig. 17.

Dapper's Concussors.

Among electrical vibratory instruments are an electric muscle beater, which consists of a carbon ball covered with chamois, and operated by a battery; an electric massage hammer, a galvanic massage roller,

Fig. 18.

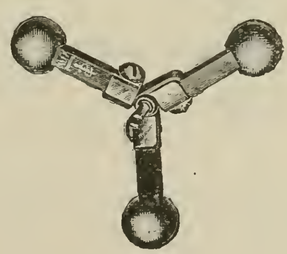


Fig. 19.

Rotary Beaters for Vibration Massage.

and larger instruments to be combined with the galvanic or faradic current, also special ear massage and electrical prostatic massage instruments.

A small apparatus makes the hand the motor

power. It consists of a metal rod about two and one-half feet in length, to one end of which a hard rubber ball about two inches in diameter is attached; at the other end of the rod is a hook-like extremity covered with rubber tubing. On this rod a sliding rod is placed at right angles to the long rod. The sliding rod is shorter than the first one mentioned and has

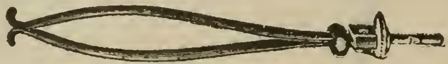


Fig. 20.—Long Fork for Tapping Massage.

three rubber balls on it, the first being adjacent to the first rod, the second midway on the second rod, and the third and smallest at its distal end. To operate it the covered end should be placed in contact with the part to be treated; the ball end being held with one hand and with the thumb and index

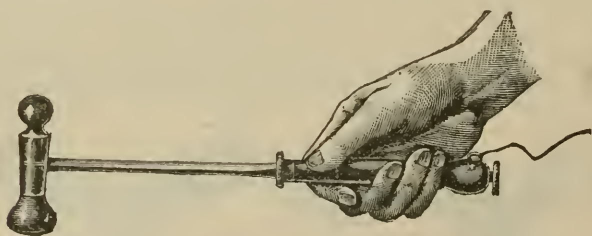


Fig. 21.—Vibration Apparatus for Hand Use.

finger of the other hand the sliding rod should be moved to and fro. Fine, but not powerful, vibrations are thus produced.

Zander of Stockholm, Taylor of New York and Kellogg of Michigan were among the noted pioneers in the induction of mechanical vibration with non-portable apparatus. Among such apparatus was a vibrating chair, platform, bar and apparatus for

mechanical beating, friction, kneading and trunk rolling. These were the fore-runners of modern vibrators. Many of the movements so produced were similar, but were not so easily applied as the more recent productions. They operated by vibrating the patient en masse, not in part.

Owing to the recognition of mechanical vibration by the profession, and the results obtained by its scientific application, many vibrators have appeared on the market. Some of these are excellent and fill the requirements of a first class machine, whereas others are inferior. It behooves the practitioner to acquaint himself with the essentials of a good ma-

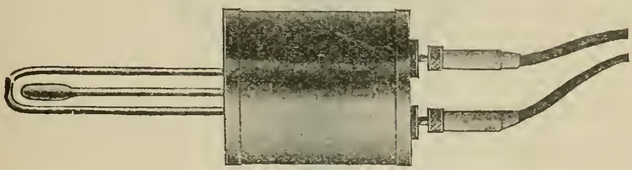


Fig. 22—Hutches Vibratile.

chine, and to consider the therapeutic requirements before purchasing an apparatus.

A serviceable type of flexible shaft machine (Figs. 23 and 24) comprises an electric " motor specially wound to give proper speed for the work and is provided with a speed controller in base " for use with the direct current. The pedestal is adjustable and provided with a rotating top. The stroke is obtained by the revolving of an eccentric, which is readily adjusted for the regulation of the stroke. The machine is operated by a 220-volt, or 110-volt, direct current, or by an alternating current. The outfit in the latter case has " an alternating current motor so connected that the speed is regulated perfectly by

mechanical means, thus obviating the constant destructive sparking that is inevitable when commutators are used on alternating current motors." It

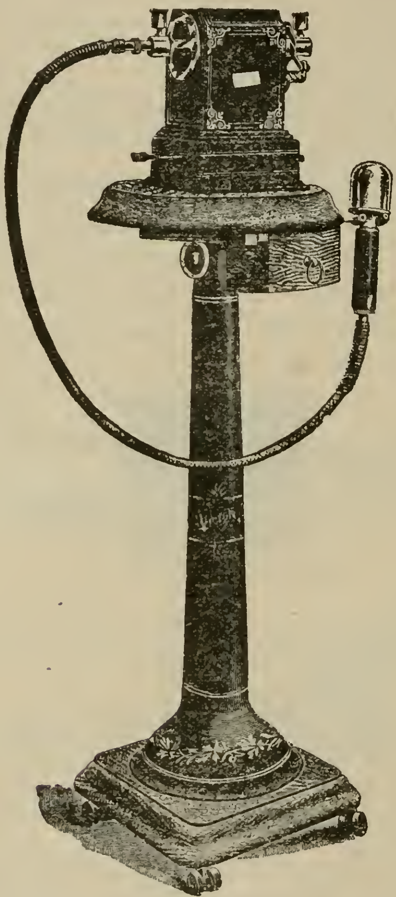


Fig. 23.—A Flexible Shaft Machine.

can be used with a 60, 125 or 133 cycle current. Another form or type of machine has a peculiar handle which imparts a lateral rubbing movement to the applicator. Another form (Fig. 25) of the same machine is a combination pneumatic and mechanical

vibratory massage outfit, which consists of a special motor that can be operated at any speed from 200 revolutions per minute to 6000 revolutions per minute, two speed controllers, one for the pump and one for the vibrator handle, a pneumatic pump that gives a stroke from 0 to 1¼ inches, and a vibratory massage handle. The pump gives four air movements,

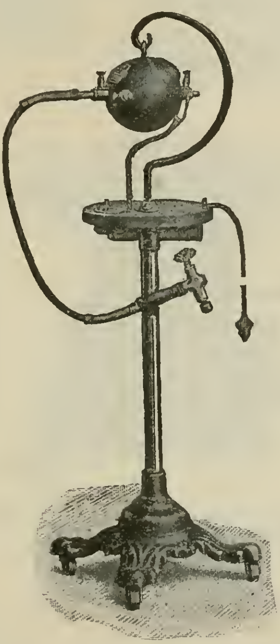


Fig. 24.—A Flexible Shaft Machine.

straight exhaust or suction, suction with release, alternate suction and compression, and a succession of forward impulses or compression. An otoscope, which is also necessary in ear massage, and glass cups for eye treatment are provided. In the handle is an air port hole, which is covered by the thumb of the operator during an administration, allowing him to control the escape of air. The cable is provided with

six attachments and the handle has a removable cap and a device for regulating the strength of the vibrations. By means of a two-speed countershaft it is possible to use any size motor, water or electric. Of the numerous vibratodes (Fig. 26) made for use with the apparatus are: a small rubber cone, a medium sized soft rubber cone, an extra large one and two soft rubber cones for special work, a straight probe, a straight rectal applicator for internal use,

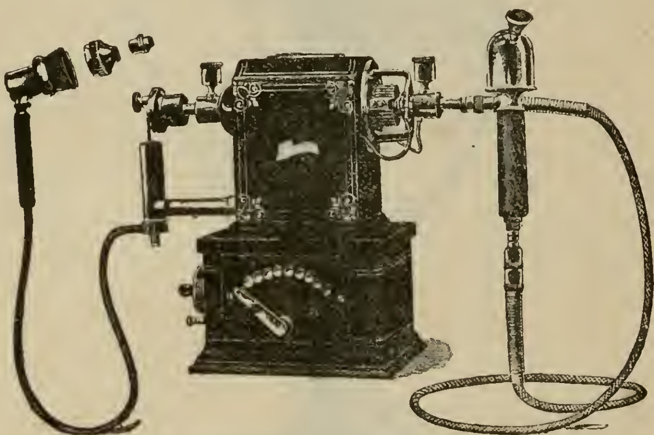


Fig. 25.—Vibrator with Pneumatic Attachment.

an internal rectal applicator with spring to lessen severity of vibrations, a rectal for external use, a curved applicator for the throat, one cone of hard rubber, a large and small corrugated rubber disc, a cushioned applicator, a probe with springs, a probe with twisted silver wire with eyelet to carry medicated ribbon, a convex hard rubber vibratode, a large convex hard rubber muscle roller, a large concave heart applicator and a spinal applicator, fingers separated sufficiently to span the spine. Special vibratodes include a 12-inch rectal vibratode with flushing

attachment. The vibratodes may be attached in a straight line with the handle, or at right angles to it. The weight in the cap-shield has a rotary motion which imparts a tapping motion to the vibratode.

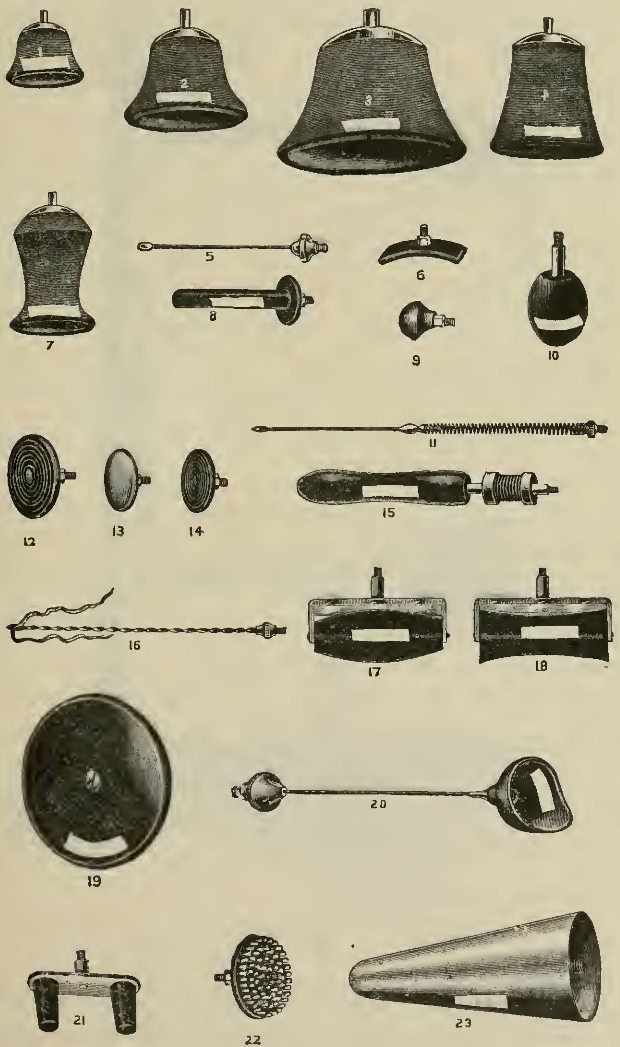


Fig. 26.—Vibratodes.

Another form of machine comprises a transformer motor which is operated by a switch giving perfect control of speed; on one end a massage handle or a

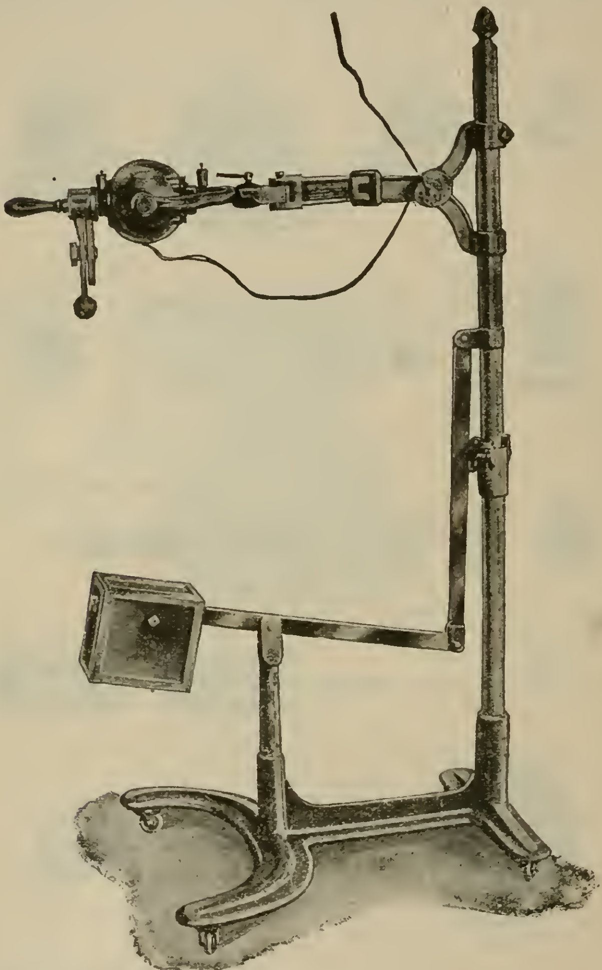


Fig. 27.—A Rigid Arm Vibrator.

nasal drill can be attached, and on the other end a small pump is attached which is used for aural and other forms of pneumo-massage.

This motor also transforms the direct current into the alternating, which is again passed into another transformer, which delivers a cautery current sufficient to heat any knife, and also a current for lighting diagnostic lights.

Another flexible shaft vibrator consists of a ball bearing oscillating lever revolving on its own axis, with a ball bearing sliding fulcrum provided with a take-up for perfect adjustment. This construction, with the ball bearings running in a heavy grease, ensures operation with a minimum of friction, no lost motion, noiseless running and a remarkable smoothness of stroke, which remains constant irrespective of the pressure exercised. The stroke is instantly adjustable and the vibrator is interchangeable throughout, no moving parts are exposed and vibratodes are easily and quickly adjusted.

The most widely known rigid arm machine (Fig. 27) consists of a perpendicular bar mounted on a metal base at right angles to it. To the perpendicular bar is attached one end of a jointed arm supporting a weight, the other arm being supported by a short perpendicular bar to the base. On the upper part of the long perpendicular bar is a rigid jointed arm supporting a motor, to one side of which is attached the metal handle bar with its perpendicular attachment, on the end of which are screwed the vibratodes. The rigidity of the arm is a particular feature of this apparatus. It can be operated by the direct or alternating electric current.

By means of two adjusting devices the vibratodes as a whole can be swung backwards and forwards, or from side to side. The motor is connected by insulated cords to a plug screwed into an incandescent

lamp socket. The holder of the vibratode has a short shaft clamped by a nut on each side, which can be shifted in such a manner as to lengthen or shorten the stroke. The motion of the vibratode itself is to and fro in one plane. The attachments employed with this instrument are a hard rubber rectal, a throat attachment, a hard rubber ball for spinal work, a soft rubber brush, or multiple point vibratode, and a rubber cup.

A mechanical vibration apparatus which employs compressed air or liquid carbonic acid gas as power consists of a handle which is surmounted by a horizontal tube, the upper part of which is surmounted by a small metal chamber containing four air chambers. The horizontal tube contains the piston, with three air spaces into which three of the four air chambers open, the fourth air chamber opening into the space not occupied by the piston, the rush of air from which causes the piston to move forwards and backwards in the horizontal tube which imparts an up and down motion to the vibratode, which is introduced into this holder, the opposite end of which makes one end of the horizontal tube. The handle is connected with the atomizer valve or shut-off of any air tank or nebulizer outfit by a flexible rubber tube. The motion imparted is an up and down stroke. The following vibratodes are provided with the apparatus; one for the uterus, one straight and one curved probe for mucous cavities, a roller vibratode, a multiple knobbed one for applications over the abdominal viscera, a soft-cushioned disc vibratode and a small hard one for body vibration, a small soft cone for the face and arms, a large soft rubber cone for aural massage, a soft rubber rectal-uterine,

and an extremely long soft rubber rectal probe (Fig. 28). It is claimed that only five pounds of air pressure are necessary to operate it, though oftener 15 to 25 pounds pressure are desired. It will produce over 7000 impulses per minute of a quality ranging from a most delicate touch to energetic vibratory impulse. The air pressure should be varied to the requirements of the parts treated. Twelve pounds is sufficient for application to the throat and neck; ten pounds for the liver, and twenty pounds for the treatment of hemorrhoids.

Dr. Abrams, author of "Spondylotherapy," employs an apparatus which is essentially a pneumatic hammer, giving a stroke of 1¼ inches and operated

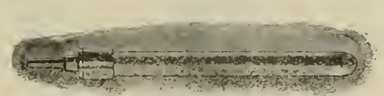


Fig. 28.—Long Rectal Vibratode.

by compressed air. The force of the concussion blow may "be regulated by a stop-cock or by the pressure of the concussor on the spinous processes." The concussors vary in size "to include one, two, three or more spinous processes."

If a compressed air outfit be employed for power, a power pump is to be preferred to a hand pump. No hydraulic air compressor is satisfactory unless at least "30 pounds faucet water pressure" can be furnished.

An oscillator (Fig. 29) is a combined type of apparatus; an oscillatory as well as a vibratory treatment can be administered with it. It is operated by an electric motor and consists of a standard, the head of which is a short, horizontal shaft, on each

end of which is a wheel, provided on each outer surface with an eccentric. The motor power may be either gas, water or electricity. The motor is con-

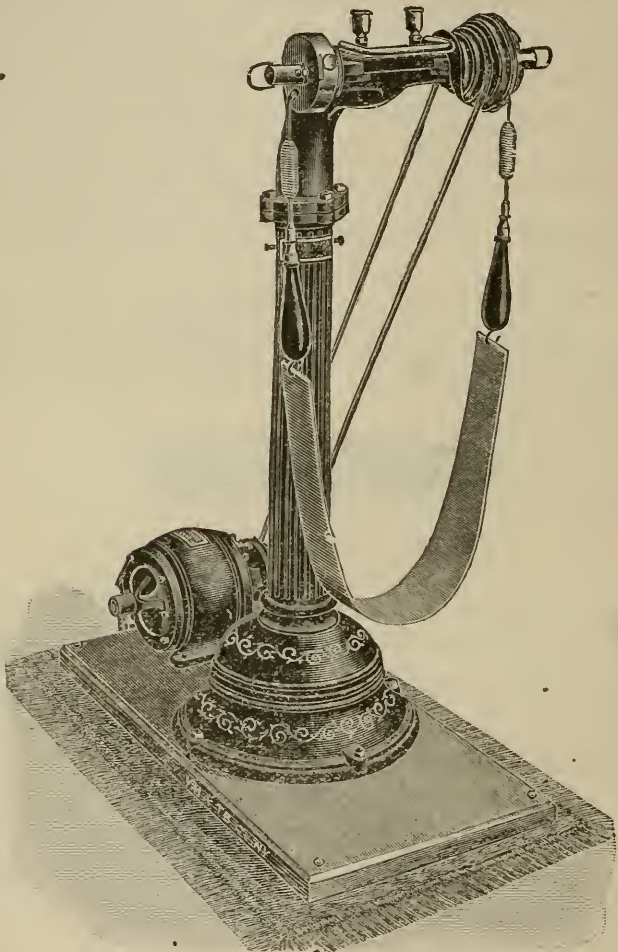


Fig. 29.—An Oscillator.

nected to the pulleys on the head of the vibrator by a belt. The applicators for oscillation consist of a broad belt, a narrow belt, a hand piece and a foot rest.

A millimeter scale is marked on the side of each eccentric, which, when employing oscillation, should be adjusted the same distance from the center of each axis. After loosening each set screw, shift each eccentric the indicated distance from the center, the distance being regulated to the fineness of oscillatory movement desired, one millimeter or one and one-half millimeters being very fine and suitable to use with the smaller belt for the treatment of headaches or in ear or throat cases; two and one-half millimeters or so for cases where the hand-piece is used. Two to eight or nine millimeters are usually used with the large belt applied to the body unless very powerful work is required, when ten or eleven millimeters may be used, the limit being sixteen millimeters. After adjustment tighten the set screws. The motor for good work should make at least 2000 revolutions per minute, the speed being regulated by a system of pulleys for use with the alternating current, or pulleys and rheostat when the direct current is employed. When the hand-piece is used, only one eccentric is employed, the other having been put on center, but with the other applications both eccentrics are used. The belts should be non-elastic and firm. The hand applicator may be used in combination with the faradic or galvanic battery. The belt applicator may also be used with electricity.

The action of the tissue oscillator differs from a percussion stroke—it produces oscillation, having a two-fold vibratory effect; the motion being governed by both eccentrics. When the motion is governed by one eccentric, vibration in its limited sense is produced. A revolving stool, and one or two high-backed chairs, one with and one without arms, are useful

in giving treatment, but when the hand-applicator is applied administration may be given lying down. Two hand-applicators may be used together in such a manner that they may be applied as in heart massage.

To use the belt, adjust the eccentrics, direct the patient, if a body treatment is desired, to remove the corsets or coat and vest, and facing the machine adjust the belt. He must make a pull of about twenty-five pounds on it in order to keep it taut. At

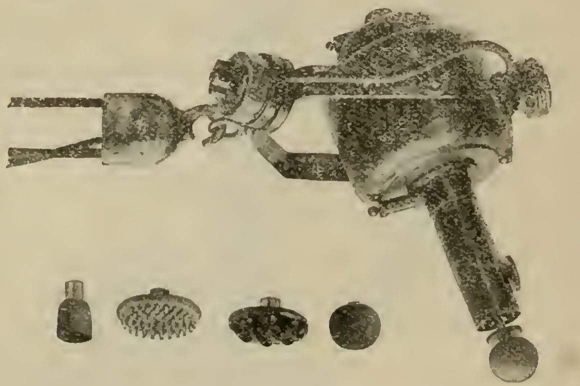


Fig. 30.—Counter-weight Vibrator

the same time the hands should be kept upon the handles to keep them in line.

An improvement in the above apparatus is the addition of a *flexible shaft* for the administration of forms of vibration other than the oscillatory. The end of the flexible shaft is inserted into the open screw end at the side of the oscillator; a set screw is provided which enables the operator to tighten it down firmly. Both eccentrics must be adjusted on the center before using the vibrator attachment. It is preferable to insert the vibration shaft on the

heavy or pulley side of the oscillator. Any possible speed may be used and regulated by the pulleys or rheostat when the direct current is used. If the greatest speed is desired, place the pulley belt on the inside cone or steps of pulleys. Any flexible shaft can be used.

A vibrator has been perfected to be run with dry

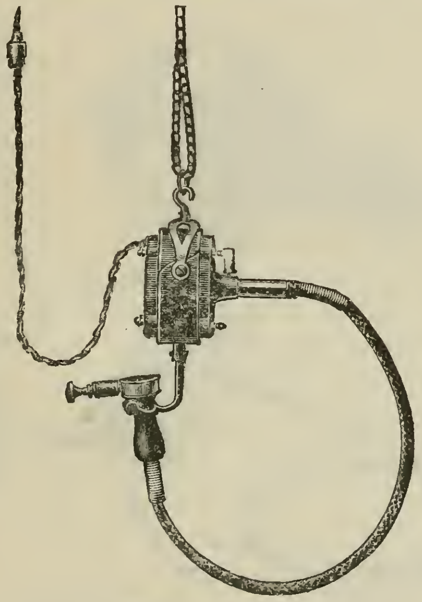


Fig. 31.—Hanging Type of Vibrator.

cells. It is claimed that the cost of a machine operated in this way giving full power of a stationary machine is about fifteen cents per hour.

A "counterweight" vibrator (Fig. 30) is a machine without a rigid arm or a flexible shaft, "the hand piece being attached to the motor in such a way that it can be adapted to any part of the body. The motor is suspended from an arm that is supported by a spring. The hand piece is so attached

to the motor that the direction of the stroke can be changed without changing the position of the motor. This is attached to the wall." It has a wide range of action. It is claimed that its vibrations are not transmitted.

For the general practitioner a portable apparatus is valuable. Portable machines are all made on

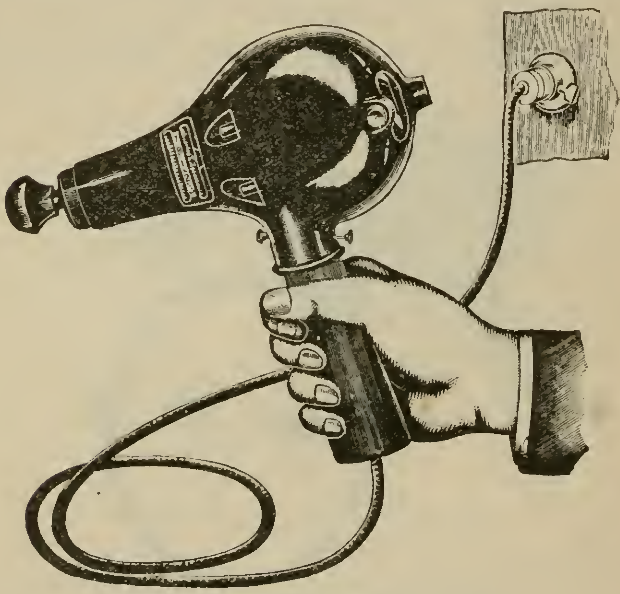


Fig. 32.—Type of Portable Vibrator.

about the same principle. A favorite type (Fig. 32) consists of a motor to which is attached a handle connected by a cord to a suitable plug which can be connected to a lamp socket. The vibratode is connected to one end of the motor. It gives a "percussion and a synchronous oscillatory stroke" which has a wide range made by "the manipulation of the knurled regulating thumb wheel." A visible scale shows the strength of vibration being used. Vi-

bratodes and a suitable case complete the outfit, which weighs three pounds. A transforming connection can be used so the vibrator may be used where there is an alternating current as well as where a direct current only is at hand.

As early as 1808 Dr. Thomas S. Dowse,* Fellow of the College of Physicians of Edinburgh, used the faradic current with two damp chamois-covered metal electrodes, or sponge electrodes, and the galvanic with sponge electrodes as well as a unipolar current from the static machine for administering vibra-massage.

Dr. Morris W. Brinkmann, of New York, for the application of selective, harmonic, electric vibration uses "an apparatus,† having three ribbon vibrators of different thicknesses, each being adjustable for tension by its own lever and thumbscrew; each also having its own contact point and individual adjustment. The primary current, instead of passing through the ordinary spring or ribbon vibrator, was split into two or three divisions according to the number of ribbons in use. We therefore get induced currents in the secondary of desired speeds, as determined by the tension or attunement adjustments. The current tension is regulated by the amount of current allowed to pass through the primary, the amount of secondary embracing the primary, and the particular winding of the secondary used."

Considerable discussion has arisen from time to time as to whether this or that machine was properly a mechanical vibrator. Some claim that a "vibrator

*Dowse. Lectures on Massage and Electricity in the Treatment of Disease.

† Journal of Advanced Therapeutics.

must have a to-and-fro motion," and others that one apparatus rotates, another percusses, another pounds, and still another shakes. The subject of vibration must be considered in a broader sense, as correctly considered, a vibration is " a recurrent change of position."

Modern mechanical vibrators classified according to the manner of stroke are:

1. Those which have a to and fro motion in one direction or plane.
2. Those characterized by an up and down motion.
3. Those which have distinct oscillations.
4. Those which have a lateral motion in all planes of a rotary motion.

The essential elements of a good machine are as follows, when considered not therapeutically but with reference to mechanism. It should be constructed so as not to injure, by soiling or tearing, the patient's clothing; the vibrations of uniform quality should be capable of a range from weak to strong, and the force of impulse and rate, or speed, should be under control (the rate ranging as high as 6500 per minute), and the stroke should be adjustable. It should be easily moved about, easily operated, and readily adapted to the part to be treated. It should have the least possible frictional wear, and the vibratodes should be easily adjusted. The apparatus should be so constructed as not to be easily broken or put out of repair. Weight and transmitted vibrations to the operator are objectionable features. A purchaser should always remember that an apparatus is " no more durable than its weakest part."

The numerous mechanical vibrators of the present day differ in size, in form, in the supporting arm—flexible or rigid—in the motor power,—hand, electric, gas, water, etc.; in the form of vibratodes; in the composition of vibratodes, as metal, hard rubber, soft rubber, spongy rubber, and compressible containing air; the kind of stroke,—lateral or to and fro, tapping or rotary; and in the range of speed and applicability. Some are much more meritorious than others. The selection of a machine should depend upon the work to be done. None of them are perfect, but all have merit. As Dr. George H. Taylor* so aptly states, " Mechanical impulse may be so applied as to oppose the end sought, and actually to operate in the direction of morbid activity, it may obstruct physiological endeavor." There must be such an " adaptation of mechanical processes as will successfully blend with the various physiological processes."

*Taylor. Massage.

CHAPTER III

Systems of Vibration Therapy

There are various methods of applying mechanical vibration, but up to the present too little attention has been given to the determination of scientific modes of application. Two methods in general are in vogue, one having central nerve stimulation as its basis, the other being founded on manual massage including friction particularly.

The application of mechanical vibration is subject to great latitude, varying from the employment of a portable machine operated by hand power to an elaborate apparatus whose motor power is electricity. The average physician has little time for manual massage, which naturally falls to a trained masseur; and as this is written for physicians and not for masseurs, the application of the various hand devices for administering mechanical vibration by percussion, concussion or tapping will not be considered. In order to familiarize the reader with what has thus far been accomplished, a few methods will be included.

The basis for treatment for the application of mechanical vibration as treated by Pilgrim* based on central nerve stimulation is as follows:

The spinal cord is

(1) "The principal seat of reflex nerve action.

(2) It is the center of the vaso-motor system.

*Pilgrim. Mechanical Vibratory Stimulation.

(3) It exercises an automatic action over the arterial tone and various viscera.

(4) It is the index of abnormal action in many parts of the body."

From this standpoint, vibratory treatment for the relief of pain may be applied in three ways, as summarized by the the same authority.

(1) "Application of the inhibitory stroke to the spinal nerve *centers,* supplying *sensory fibres* to the affected part.

(2) Stimulation of the *vaso-motor centers.*

(3) Inhibition of the *peripheral termination* of the *sensory fibres."*

"Affected nerve centers are evidenced by the presence of muscles in a state of contraction, atrophy of muscle or muscles overlying the posterior primary divisions of the spinal nerves, and vertebral spreading or deviation."

Although the patient may be treated in a sitting posture those who use machines generally prefer to have him lie on a narrow hard-cushioned table. The table should be about six feet long and twenty inches wide in order that the operator may easily reach across during the administration. For spinal treatment the prone position is assumed with the face down and the arms hanging loosely over each side of the table. When the thorax is to be treated a pillow may be placed beneath the posterior portion of the chest.

When mechanical vibration is to be applied to the region of the neck with the patient lying, the patient's head should be turned on the pillow so as to provide a resisting surface, or in some cases no pillow need be used. It is a recognized fact that an

opposing resistance increases the value and efficacy of vibratory treatment.

It is best that ladies remove their corsets, in fact all clothing about the waist but the undervest, and that a man should remove his vest, coat, suspenders, and stiff-bosomed shirt.

The following relative to vibratory technique as outlined by Pilgrim may be of interest.

The duration of treatment is usually from two to four or five minutes and each individual part should not be treated for a longer time than five or eight seconds for stimulation, or ten to twenty seconds for inhibition—bearing in mind that stimulation, vibratory stimulation, or inhibition depend relatively upon pressure and length of stroke as well as time. If what is termed stimulation be desired, the brush (multiple point vibratode) should be applied for a few seconds, using light pressure and medium stroke; if vibratory stimulation is desired, a slightly longer application according to Pilgrim, " eight to twelve seconds," with tolerably deep pressure is necessary, and actual inhibition is brought about in from a quarter of a minute to a minute or more, employing deep pressure with the ball. The writer believes that the condition under treatment, the immediate response of the patient to treatment during previous administrations and the after effects must be the guide as to length of time requisite to obtain the effect desired. Great care must be taken not to make the treatment too long, or, what is a matter of the utmost importance in the writer's judgment, to exert too great pressure, as the treatment might be followed by a sense of great weariness or lassitude.

In the treatment of pathological conditions affecting the organs of special sense the following general plan is adopted. First, consider the nervous supply of the organ and its general relationship. If it is indicated to treat the superior cervical ganglion, apply vibration to the upper part of the anterior border of the sternocleido-mastoid muscle, or if lower in the neck it may be treated indirectly through the other cervical ganglia, applying the vibratode in front of the transverse processes.

In venereal diseases, according to instructions, based on central nerve stimulation, developed by Dr. Pilgrim, the treatment should be as follows:

(1) " Stimulate with the rubber ball the proper vaso-motor area for the purpose of inducing a more efficient blood flow, and the nerve area in the spine, which controls the nutrition of the genital or other affected organs which, under such conditions, are quite sensitive to deep pressure.

(2) Stimulate with the brush the lymphatics generally, but especially those along the sides of the penis and in the inguinal region, in order to secure the best drainage possible, relaxing at the same time all contiguous muscular tissue.

(3) Stimulate at their nerve connections at the spine (with the ball), and also directly over the organs, with the brush, the liver, kidneys, spleen and bowels, with a view of accelerating their eliminative action.

(4) Place the patient in the ' Sim's ' position, with knees well elevated, shorten the stroke of the vibrator arm and apply a mild treatment to the pros-

tate gland per rectum, using for this purpose the special rectal attachment.

WHEN TREATING THE AFFECTED SPINAL CENTERS treatment should be applied just inside of the tuberosities of the ischium, deeply, immediately behind the attachments of the perinaeum, using the ball and medium stroke."

IF THE STIMULATION BE SPINAL, the ball attachment is applied between the transverse processes. Great care must be exercised to avoid the spinous processes. This treatment is based on the idea that pain is of nervous origin and by treating the centers of such nerves we can act upon the affected part.

OTHER SPECIAL CONDITIONS are treated in accordance with the theories on which the above line of treatment is based. One very unique method was recommended by Pilgrim* for flushing the mesenteric glands in cases of alcoholism or morphinism as follows: "The patient should drink a pint at least of water (hot if for the former condition, and hot or cold for the latter) and then lie on his right side with the knees well elevated. Vibratory stimulation with the ball should then be applied to the spine between the fourth and fifth dorsal vertebræ, using firm and tolerably deep pressure." This should be continued for one minute and is done to relax the pylorus. "Next place the hand over the abdomen, just below the stomach, and exert heavy upward pressure with a view to elevating the stomach. When this is accomplished, the contents of the stomach will rapidly discharge into the abdomen without much absorption taking place through the gastric glands."

*Pilgrim. Mechanical Vibratory Stimulation.

After this stimulate the splanchnic nerves to hasten absorption by means of the mesenteric glands.

The above is only a brief outline of the method employed by many advocates of vibration.

THE METHODS that have been followed by other advocates of vibration more closely follow the forms of manual massage. As an example the following is noted in respect to neuralgia. One writer states that the best way " of treating neuralgia with vibratory massage, is to ' coup ' the pain by immediate application of very powerful vibrations for a short period, one-quarter to one-half minute, and then continue with milder, but increasing vibrations over the pain points and along the course of the nerve, up and down and then finish with vibrations of the initial strength and duration. There is however one obstacle to the successful carrying out of the above treatment, viz., the inability of most patients to withstand the shock of the ' couping.' Therefore, one must mostly resort at the beginning to moderately strong vibrations and then increase until the limit, to be determined by the patient. Milder vibrations will cure but not so rapidly. The element of time varies " from two to twenty minutes, and two treatments per day have been necessary in some cases.

THE ACTION OF THE TISSUE OSCILLATOR is somewhat different from that of a mechanical vibrator. By some its action is regarded as closely resembling that of a mechanical exerciser, such as some of the apparatus of Zander and Taylor.

In using this apparatus the patient sits or stands, or he may recline when the hand piece is applied to the back or when the new additional vibratory attachment is used. If the patient applies the hand piece,

a chair with arms is desirable, otherwise the chair without arms is to be preferred. Chairs should be firmly fastened to the floor. The patient may under certain conditions remove nothing but the hat, in others, as for throat applications, the collar, or for foot applications, the shoes must be removed. If a woman is to be treated, corsets or tight clothing should be discarded. In the case of a man, suspenders and stiff-bosomed shirt should be removed. Of course an application to the exposed skin is oftentimes desirable in order to secure the full effects, in which the clothing to be removed will be determined by the judgment of the operator.

If a body treatment is indicated the wide belt should be used and the administration made with the patient standing. Usually abdominal or spinal treatments are best given with the patient standing, as he can more easily hold the belt taut. In almost all other cases sitting is advised. An application as a whole may last from a few to seven or eight minutes, although some employ it for a longer period when treating exceptionally vigorous patients. Usually the effect produced instead of the time will best serve as a guide, but it is well under no conditions to make the treatment exceptionally long. The same rule obtains as with all cases under mechanical vibratory treatment, viz., the first administration should be made shorter and milder than those following.

The frequency of treatment is left mostly to the judgment of the operator. Daily treatments at first followed by treatments three times a week is the general rule, but the rule of electro-therapeutics is applicable to oscillation; a daily treatment unless other-

wise indicated is best at first, to be followed later by one on alternate days, every third day, or two or three times weekly, according as the relief can be "bridged over"—that is, the effect produced should last until or almost until the following treatment—until the conditions are finally relieved.

This machine affords a vigorous means of massaging the abdomen. Observe the law of exercise—do not exercise on a full stomach or immediately following other exercise or exertion. The dosage should be regulated according to the effect sought, based upon its use according to Monell* as follows, to "(1) Accelerate the general or local circulation. (2) Determine an increased supply of blood to a part. (3) Increase under-nutrition. (4) Excite over-oxidation. (5) Relieve pain or muscular stiffness. (6) Stimulate internal organs to improve functions. (7) Tone up atonic muscle fibres. (8) Increase secretion, especially of the liver and digestive apparatus. (9) Increase peristaltic action of the intestinal tract. (10) Secure the effects of fine rapid vibration."

To regulate the length of stroke an eccentric provided for the purpose should be adjusted to one or one and one-half millimeters for a fine stroke. A stroke of one and one-half millimeters is best adapted for work about the neck when the smaller belt is used. The use of over two and one-half millimeters is not advisable when the hand piece is employed. With the large belt a stroke of from three to eight or nine millimeters may be used according to the size and tolerance of the patient, as well as the condition of the part treated. Beyond this limit the strokes become actual muscle and body exercisers.

*Monell. A Pictorial System of Instruction, page 611.

The employment of special applicators will be considered in connection with the treatment of particular parts. The use of the hand applicator with this apparatus is illustrated in the treatment of the ear. Remove the distal end portion of one handle and lock the eccentric on the same side at zero, then unscrew the set screw of the other eccentric and adjust it so as to secure a stroke of about one millimeter and in place of the lower part of the other handle attach the hand applicator. One eccentric being locked, vibrations instead of oscillations occur. The operator should strap his hand to the applicator and use his finger tips or thumb tip in making the applications, the vibrations being transmitted through the hand of the operator to the patient. The handle bar should always be rigid during administrations as a deviation affects the vibrations. It is desirable in the writer's opinion to start the vibrations before applying the hand to the region to be treated and thereby avoid shock and discomfort. With one finger tip, using well regulated pressure, treatment may be given over an area where administration is indicated, as the Eustachian tube, larynx, or pharynx.

The treatment of myalgia of the neck has been followed by good results by the use of the narrow belt in the writer's experience, employing the apparatus as follows: Adjust each eccentric so the stroke will be about one and one-half millimeters and tighten the set screw. To the lower part of each handle hook on the narrow belt. Have the patient remove her hat and collar and adjust the belt. She should sit in the chair at such a distance as to bring the belt taut, and the handles must be in line. Start the motor at a rapid rate of speed. At the end of

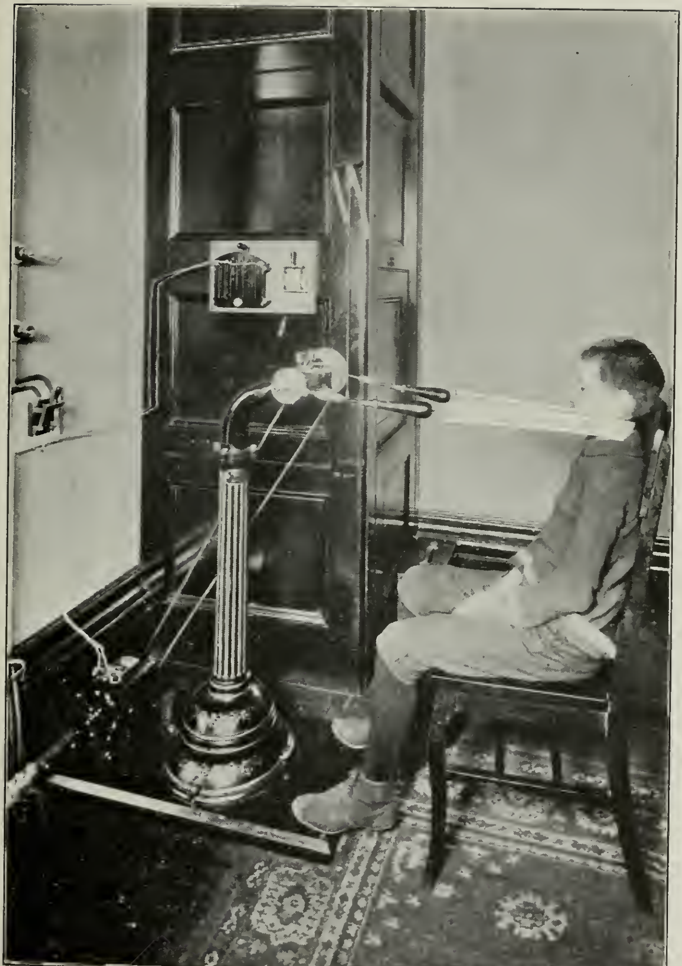


PLATE II.—Treatment of Myalgia with the Oscillator.

five minutes the patient under such treatment was able to move her neck freely. When the large belt is used the patient should stand in such a position as to throw a weight of about twenty-five pounds upon the belt in order to keep it taut.

In respect to the treatment of the extremities, taking the foot as an example, as it will also demonstrate the method of using the foot rest, the method is as follows: Seat the patient facing the apparatus with legs extended. It is best, although not absolutely necessary, that the shoes be removed. Hook the foot rest to each handle bar. The patient should then place her feet in the foot rest and hold the belt in her hands, or have it fastened around her body, or around the chair, as it must be held taut. Three or four millimeters as indicated on the eccentric of this apparatus will usually give a stroke of sufficient length for this administration. The treatment should be continued for about five minutes, unless existing conditions indicate otherwise, and a short rest should follow before the patient leaves the office. This treatment is adapted to patients suffering from poor circulation and cold feet.

Electricity can be administered during the treatment with the applicators, but is not considered a valuable combination. A vibratory attachment also increases the usefulness of the apparatus. Dr. Morse,* of Boston, describes a practical method of treating auto-intoxication as follows: "My first treatment consisted of a gastric lavage, not by the usual method of swallowing a tube, but by having the patient drink half pint of a solution of sodium phosphate and sodium salicylate, followed by one

*Journal of Advanced Therapeutics.

or two glasses of Poland water, shaking him vigorously by placing the band of the oscillator over and around the stomach, after which having him lie for five minutes on his right side that the solution might gravitate into the duodenum." This procedure was followed by " a sinusoidal surging current through the duodenum for five minutes and the static wave current over the parts for five minutes." This treatment caused a marked elimination of toxic material resulting in a rise of temperature, quickened pulse and slightly swollen and tender joints. An active cathartic was then given to eliminate the toxic material.

In the adaptation of all machines to therapeutics, the operator must consider many features other than the directions generally given, for the relative strokes, speed, and pressure of and with different machines vary. He should always test the application of each particular vibratode with varying degrees of speed and stroke and pressure on himself at the same site he is to treat the patient; for without so doing he cannot rightly appreciate effects or obtain the best results.

CHAPTER IV

Methods of Application of Mechanical Vibration

Mechanical-vibration or vibra-massage in the modern sense produces *vibration* as understood by physicists, whether that motion be to and fro in one plane, up and down, percussory, oscillatory, mixed recurrent or rotary. When a vibration is induced through connected particles of matter a succession of waves are set in motion which form a line known as the *wave line.* From a fixed point on one wave to a corresponding point on the next is one *wave length.* When several wave lengths send impulses throughout a given area, motion from each follows resulting in interference. *Interference* may increase, decrease, or inhibit motion. It may cause areas of different degrees of vibration, and in membranes, etc., it may result in vibration in segments or stationary vibrations, the points of least vibration being called *nodes,* the points of greatest motion, *antinodes,* and the portion between two nodes, a *ventral segment* or *loop.* The resultant wave will be longitudinal if the particles in vibration and the wave path be in the same direction, or transverse when they are in opposite directions. The rapidity of the wave transmission is increased with the increase of the elasticity of the medium as it more easily transmits " waves made up of condensations and rarefactions," hence the elasticity of the region treated will influence the effect. Therefore with a given rate of vibration one tissue or organ may have few waves transmitted in

a given time, whereas another may have many consisting of nodes, antinodes, and loops produced with marked rapidity under which conditions physiological inhibition may be induced instead of stimulation. It is also possible in an organization so intricate and complex as the human body that *sympathetic* vibrations may be elicited in certain parts in harmony, i. e., having the same periods of vibration. When the vibration period peculiar to a particular part is not recognized, mechanical vibration may cause *forced vibrations.* Gage* states that "When a vibratile body is compelled to surrender its own vibration period and to vibrate in an arbitrary manner imposed upon it by another, the phenomenon is known as forced vibrations," which may occur when mechanical vibration is applied to a part.

THE STUDY OF HARMONIC VIBRATION is a field yet requiring much investigation, but in connection with it, it must be remembered that an increase in the number of vibrations shortens the wave length and increases the pitch and that "the vibration frequency of strings of the same material varies inversely as their lengths and the square roots of their weights and directly as the square roots of their tensions." All of which are important factors to be considered.

Vibration may be administered in the following forms, irrespective of the type of vibrator—although some vibrators may be found to be more suitable for some modes of application than others.

1. INTERRUPTED VIBRATION is an interrupted vibratory impulse communicated to the body without pressure, or with varying degrees of pressure.

* Gage. Elements of Physics.

A. *Superficial* without pressure.

B. *Deep* with light, moderate, or heavy pressure. Heavy pressure may be *compressing* in character.

2. STROKING—a superficial vibratory impulse applied with motion over a part, no pressure being exerted.

3. FRICTION—a deep vibratory impulse applied with motion, and varying degrees of pressure over a part. The subdivisions according to directions are:

A. *Centripetal* vibratory friction.

B. *Centrifugal* vibratory friction.

C. *Circular* vibratory friction.

4. ROLLING—a forward and backward movement of a part over underlying structures. It is a form of kneading.

THE OPERATING ROOM should be well ventilated and warm (about 75° F.), because the chilling of a patient causes unnecessary discomfort and induces a state of muscular contraction whereas all parts should be relaxed or in a state of repose when being treated.

THE FURNITURE NECESSARY will depend somewhat on the type of machine used. In general, a long, hard table, the height of an operating table, which can be elevated at either end is desirable. Two adjustable arm rests are a convenience for treating the arms if the operator has no assistant, as the best work can only be accomplished when all parts are in a state of relaxation, and are properly supported. Two hard pillows of different sizes will be of service. The table should not be so wide that the operator cannot easily reach across, because some machines

cannot be conveniently operated from either side. If provided with rollers it can be readily moved about by the operator which is often an advantage. A hard-cushioned Morris chair is also useful in some cases, supporting the body in a relaxed and comfortable position when it is not necessary to have more than a moderate resisting surface as when treating the eye, ear or nose. A stool is useful when applying special vibration with the patient sitting. The furniture essential for use with an oscillator is mentioned in the chapter describing its therapeutic application.

Thoroughly examine each patient before treatment for obvious reasons. Prolonged mechanical vibratory treatment over a site is best given on the bare surface. If the patient is a woman and she is to lie down for treatment, she should remove waist, corsets, and all other clothing about the upper part of the body except her undervest, which,. in certain cases, as when vibratory friction is applied to the arm, should have short, loose sleeves. In some cases it is preferable to make the application to the bare skin. It is always best to cover parts not being treated. If the upper part of the body is to be treated, let the patient wear a kimona, which can easily be pushed aside as indications require. All waistbands of the underwear should be loosened, so as not to interfere with circulatory activity and to permit the tissues to be generally relaxed.

If a man is to be treated he should remove coat, vest, suspenders, collar and outer shirt, and in all cases whatever other clothing necessary so that the vibration may not be interfered with.

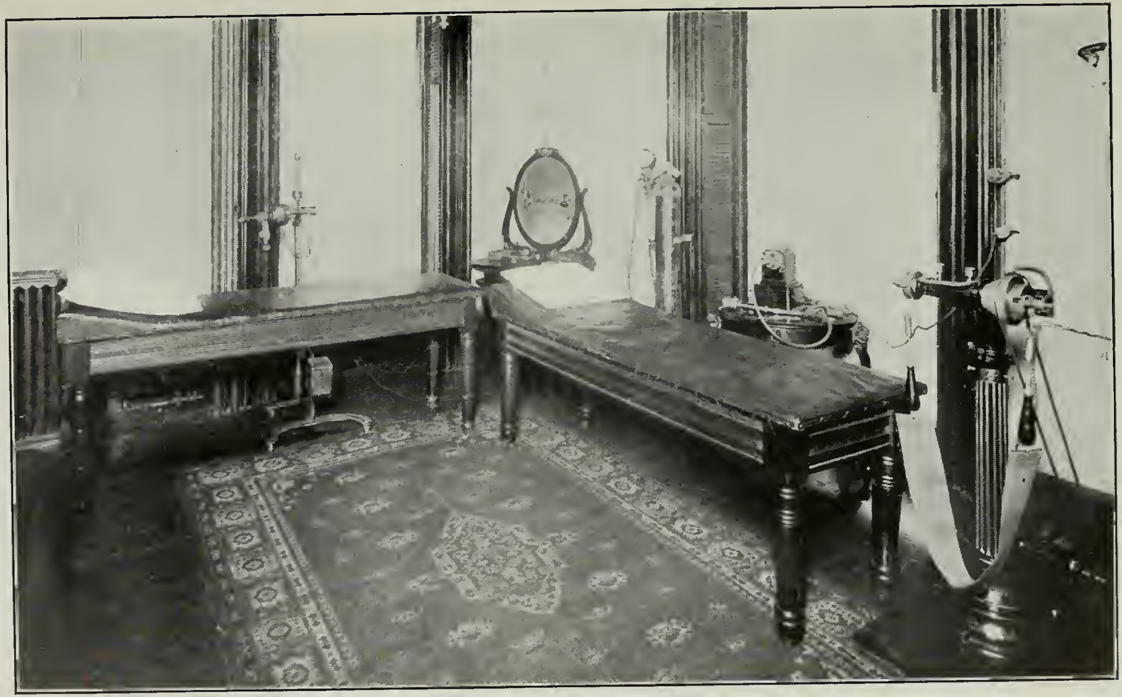


PLATE III.—Operating Room.

Interrupted vibration may be administered directly over an intervening medium unless prolonged, but mechanical vibratory stroking, friction, or rolling or prolonged interrupted vibration is best applied to the bare skin. The work should be done in a most thorough and systematic manner, with due regard to technique; and no part should be left until the treatment is finished, opposite portions of the body being best treated successively, because it is thought by some to "intensify the effect upon the nerve centers." All treatment should be mild at first, then gradually increased in pressure and speed and finally finished with diminishing motion. Painful parts should be treated with caution.

It is sometimes advisable that the patient should rest on the table for a short time after treatment and then arise slowly in order to maintain a state of absolute repose and composure so as to avoid the disturbing factors which follow sudden change from a horizontal to an upright position. It should not be inferred that vibration cannot be applied without the removal of corsets and other garments, but it is best to follow the suggestions given to obtain the best results from mechanical vibratory treatment.

The patient's posture during the treatment should depend upon the indications of the individual case. The elevation of the head should be regulated by the end sought and the comfort of the patient. In cases of œdema of the neck the lowering of the head induces a violent headache, therefore elevate the neck and shoulders with a hard pillow or pad, and if the patient is lying face downward, allow the arms to rest in a half flexed or otherwise suitable position on

the arm rests if such are provided on the table. In case the operator has no assistant and is giving a treatment to an arm or leg he may use hard-cushioned pads which serve to elevate the arms or feet as desired. An extremity is best treated when it is elevated, the patient allowing it to rest in a relaxed state. During a spinal treatment the patient should lie in the prone position, arms loosely hanging over the sides of the table, unless contra-indications exist, in order to secure relaxation of certain muscles of the back. Spinal treatments of the cervical and upper dorsal regions can sometimes be more easily administered with the patient sitting.

Joints are best treated in a position midway between flexion and extension. If the patient lies on his back, his arms may rest extended upwards on the arm rest, if one is provided on the table, toward his head, unless contra-indicated, otherwise the operator should support the joint with his left hand.

When treating the chest place a hard pillow beneath the thorax to elevate it and throw the ribs outward.

For internal rectal treatment the patient should lie on the right or left side, preferably the right, with the knees drawn up, his back being towards the machine. The knee chest position is preferred when high enemas are given with mechanical vibration. Other positions will be considered in connection with the treatment of various conditions when taken up in subsequent chapters. In all cases the position of the patient should always be such that the part treated will be relaxed and the patient comfortable. The posture should be such that the vibratode can be

easily applied, thereby assisting in securing the end desired.

The first treatment should be short in order to accommodate gradually the tissues and the patient. Although there are many who advocate treatment upon alternate days, it is better practice, the author believes, in most cases to follow the rule applied to static methods by Dr. Wm. Benham Snow in his work on "Static Electricity and the Use of the Roentgen Ray," which is to "bridge the condition of relief from treatment to treatment, lessening the frequency as the requirements permit." Usually best progress is made when daily treatments are given for four to ten days, and in some cases for longer time.

Many of the failures leading to such remarks as "Vibration gives temporary relief, but I have seen no cures, and will not give it much consideration until I do" are caused by lack of attention to technique as regards the site of application, duration of application and a non-observance of "bridging" in the management of cases. No set rule can be made as to methods which will be applicable to all cases, irrespective of cause, condition, effect to be sought or to the frequency of treatments. Such absurdity can only equal the administration of a particular dose of a drug indicated in a disease irrespective of sex, age, or idiosyncrasy, for a fixed length of time, expecting in all cases to obtain the same result.

The intervals of rest during administration should be as long or twice as long as the treatment of different parts of the body, and the periods of intermission, when interrupted vibration is applied, should be as long or twice as long as the periods of contact unless prolonged interrupted vibration is

employed. A rest of at least half an hour following the treatment will assist the "fixation and perpetuity" of the vibratory effects.

Vibration should not be administered irrespective of the duration of time elapsing after eating. It is advisable not to apply it sooner than half an hour after eating and abdominal mechanical vibration is best applied at least after the elapse of one hour.

The daily administration should be at a particular time, not in the morning one day and in the evening another. The *duration* of each treatment and the *frequency* of the interruptions during the treatment will also depend on the speed of the machine, stroke, and on the modes of application of interrupted vibration, stroking, friction, or rolling. It should vary from three minutes to fifteen, or even longer. For instance, deep or compressing interrupted vibration is relatively short, but stroking, friction and rolling are usually of longer duration. Sometimes twenty minutes or more will be required to treat a case where varied modes are indicated and results show that such prolonged administrations are not contra-indicated. The patient's physique and the conditions to be treated should always be considered. The most careful application with large experience, judgment and close observation will greatly assist the operator in making correct discrimination.

Too much stress cannot be placed on the three important factors of administration—speed, stroke, and pressure—as employed in mechanical vibration therapy.

If a moderate rate of speed be applied with a medium stroke without pressure, and the same rate

of speed and same stroke be supplemented by pressure, deeper penetration and diffusion result.

The employment of a given speed and medium stroke without exerted pressure will induce the same depth of penetration as another slower rate of speed and medium stroke with some pressure; and if the speed be much accelerated the penetration without exerted pressure will be relatively increased.

If a given speed and shortened stroke be employed without exerted pressure, the effect is more superficial than with an increased speed and same stroke with pressure. In other words, increasing the speed intensifies the effect. Effects produced by light, moderate, or heavy pressure are modified by the length of stroke, and rate of speed relative to the part to which it is applied; *what causes stimulation of one part of the body may induce inhibition in another,* other things being equal.

(1) *Pressure under all conditions* increases penetration and diffusion of vibration.

(2) *To increase or lessen speed* with a *given stroke* will increase or lessen penetration and affect the quality of the vibration, producing fine or coarse vibrations.

(3) *An increase or lessening of stroke* with a *given speed* increases or lessens penetration and affects diffusion.

In the employment of mechanical vibration due regard must be paid to stroke and speed. As a rule a low rate of speed with a sufficiently long stroke has a sedative effect on pain, and also a high rate of frequency with a medium or short stroke has a benumbing effect. Directions as to stroke in chapters following should be considered in a relative sense, for

the medium stroke of one machine corresponds to a stroke much shorter than the medium of another—stroke being an arbitrary factor.

When applying interrupted vibration to the spine, a full stroke with a moderately rapid rate of speed is desirable. The ball vibratode is used for spinal vibrations.

If applied to the eye or ear, however, the shortest possible stroke is necessary. The soft rubber cup shaped vibratode is preferred in these sites.

For abdominal work the rubber covered disc vibratode with a medium or full stroke is generally preferable.

For the administration of friction generally a medium or full stroke is to be preferred, but for vibratory stroking, the shortest stroke is in order. The rubber covered disc vibratode is used when applying friction, and either the disc or the soft rubber cup shaped vibratode is employed when stroking is indicated.

The stroke, it will be observed, should always be *adapted to the part* treated and the speed to the *indications* of the case. For example, the shortest stroke might be applicable with vibration of short duration and moderate speed for anaesthesia, but vibration of long duration with a rapid or high rate of speed should be applied for the relief of *spasm* of the same part.

Pressure as applied to vibratory therapy may be designated as light, moderate, or heavy pressure exerted by the hand of the operator when applying the vibratode. Dr. Thomas Stretch Dowse* says

*Dowse. Lectures on Massage and Electricity in the Treatment of Disease.

that "pressure is transmitted variably, according to the resisting power of the tissue to which it is applied—to its vitality—and to its mass. Pressure of *given quantity* deranges molecular integrity, alters equilibrium, and so engenders irritability and instability. Pressure of *given intensity* produces molecular inertia and death. According to the nature of the pressure applied and the resisting power of the tissue operated upon, so do we get changes in such tissues of molecular activity and irritability, or molecular derangement and death." Light pressure on the trunk of a nerve acts as a stimulus and is transmitted to the nerve. Continued deep pressure applied to a nerve induces sedation, as it benumbs and may essentially paralyze the nerve, and probably at the same time lessens the blood supply of the part.

In the employment of vibration, moderate pressure is recommended to the nerves over points or between the transverse processes on each side of the spine alternately in most cases, but of course many factors should be considered before the operator decides upon the degree of pressure to apply. Tolerance to pressure increases during an administration, and during the progress of a course of treatment.

If too great pressure be used nausea, weariness, or pain may result. Pressure over a nerve trunk should be applied with caution. Sometimes the pressure should be applied directly over the seat of pain as well as over the seat of its origin, as in neuritis.

Pressure should be light at first during an administration and gradually increased as the pain lessens to as great a degree as constantly increasing deeper pressure can be borne. If the case under treatment be a stubborn one, do not attempt to fully relieve all

of the pain at one administration. Be satisfied with a short treatment and its results, or the patient will be the sufferer.

A *moderate pressure,* but firm, is advisable when it is sought to produce spinal stimulation. The application over the spinal region should be made between the transverse processes, care being taken not to place the vibratode too close to the spine.

It should be remembered that a *heavy pressure,* especially when prolonged, produces an inhibitory effect which is exhausting. For this reason heavy pressure is applied in the form of deep interrupted vibration, as for relief over a painful motor point. Sudden heavy pressure is valuable in the treatment of some painful conditions, as neuralgia, but it should be administered with care. Zederbaum has demonstrated that sudden heavy pressure on a *nerve decreases its irritability,* but if the same pressure is gradually increased, the decrease was slower and not so "marked." A principle to be remembered was aptly stated when Dr. Geo. H. Taylor,* the noted pioneer investigator in vibratory work, said, "The *degree of force* of processes applied must be apportioned to the *degree of irritability* of the different parts of the body and must be the *greatest* to the *least* irritable parts. *Sensitiveness to impression is an approximate measure of irritability.*" Luderitz found that *motor nerve fibres are paralyzed sooner than sensory by continuous pressure.* These are reasons why we should refuse the patient's request for a longer treatment, as is sometimes the case.

TECHNIQUE requires attention and careful study, as failure or success so often depend on the method

*Taylor. Massage.

employed in vibratory treatment. A good apparatus will permit the operator to use it as the trained masseur would use his hand—according to its particular adaptability in all its forms from the lightest touch to the greatest force.

When a vibratode is applied to the surface of a patient it should not come suddenly in contact, as a blow or shock, but should be at first applied with a light touch or pressure. A light touch has a soothing effect. A cold metal vibratode is disagreeable when applied to the bare skin of the patient. It is desirable therefore that such a vibratode be warmed to about the temperature of the body before it is used.

Asepsis is also important with the promiscuous use of vibratodes. They should be thoroughly cleansed by boiling or by washing them with alcohol or solutions of carbolic acid or bichloride.

Interrupted vibration may be defined as an interrupted vibratory impulse communicated to the body without pressure or with varying degrees of pressure. It may be sub-divided into two classes, superficial and deep. The deep may be compressing in character.

(1) *Superficial interrupted vibration* may be considered a very short, light interrupted touching of the part with the vibratode.

(2) *Deep interrupted vibration,* on the other hand, may indicate a very short interrupted application of a vibratode to a part of the body with pressure—light, moderate, or heavy. *Compressing interrupted vibration* is a term which indicates very slowly interrupted vibratory compression of a part, exerted with heavy pressure. Vibration applied

with any exerted pressure, light or heavy, penetrates deeply, relative to the stroke, speed, and the structure of the part treated.

Superficial interrupted vibration is accomplished by lightly touching the part, the periods of rest being as long or twice as long as the time of contact, which should be but for a few seconds. It imparts a varied light movement, the vibration varying in rate, force, form, and rhythm, according to the speed used, and the relative power of a machine, as some machines, running at a given rate of speed and having a known power, but of a certain type of construction, impart much more force than others using the same power and running at the same rate of speed on account of the particular movement or stroke of the vibratode—to and fro, rotary, up and down, or oscillatory.

This method of vibration is applicable in the treatment of the eyes when an effect soothing in character is desired, as it acts as a sedative to the nervous system, lessening nervous irritability. It is desirable, when using superficial interrupted vibrations, that quiet prevail, as the effect thereby is intensified. This type of vibration can be employed with all machines including an oscillator provided with a hand applicator. The application can be made with the vibratode held in a sidewise or perpendicular position, the position altering somewhat the form of movement imparted, i. e., a vibratode that gives a to and fro motion in a horizontal plane if held perpendicularly, will give a percussion stroke when held oblique or parallel to the surface plane.

Deep interrupted vibration is administered by applying the vibratode with a light, moderate, or

heavy pressure to the surface of the patient for a few seconds, and then removing it. The applications should always be followed by intervals of rest as long or twice as long as the period of application unless prolonged interrupted vibration is employed. As a rule, such applications should be made three, four, or five times to a given site and should be moderate or heavy, according to indications. This form of vibration differs from superficial interrupted vibration in that some pressure is used. An administration should always be begun with light pressure, gradually increased as pain diminishes. According to Taylor,* imparted motion " contributes to and participates in chemical activity " and it is necessary that there be a certain degree of motion with pressure in order that motor energy may restore the chemical change which is present in health. He thought also that physical results were proportional to the different rates of transmitted motion, i. e., a deep interrupted vibration with light pressure, a given speed and stroke being used, gives a different degree of penetration than a moderate pressure with the same speed and stroke. The same authority believed that there are two periods for waves of motion that have been transmitted; one when " fibres, membranes and molecules glide upon each other with some degree of adhesion, promoted by pressure," this period being quite " similar in quality and rate of motion, whether the waves are long or short." The second period is at the end of the stroke when " the direction of the motion is reversed," when reinforced energy is set free into other forms of energy, principally chemical energy. One of the principal uses

*Taylor. Massage.

of this phase of vibratory work is stimulation of the spinal nerves through the internal branches of the posterior divisions of spinal nerves, and the sympathetic nerves through the rami communicantes. If the pressure applied be too great, the patient will complain of pain over the back in some cases for several days after the treatment. This has led some already to condemn and abandon vibratory treatment. Treatment should therefore be begun with light pressure, the operator bearing in mind Zederbaum's demonstration that sudden heavy pressure on a nerve decreases its irritability and that the degree of pressure should be governed by the irritability of the several parts, and must be greatest to those which are least irritable. Jacoby* of New York found that rapidly repeated percussion on the nerve of a muscle increased the muscular contractility, but if too long continued, exhausted it.

Deep interrupted vibration is applicable to œdema, swelling, pain, and congestion, and is especially useful in the treatment of joint affections. Always bear in mind that *light pressure stimulates,* and *heavy pressure exhausts.*

By compressing interrupted vibration is designated firm pressure applied to a part interruptedly. Contacts with such interruptions should in most instances be made for a number of times less than when using short interrupted vibration. It is particularly indicated for application to "motor points" and for spinal vibrations, and at painful sites for the purpose of benumbing the nerves and lessening the blood supply. Hyperæsthesia is also favorably affected by its employment. In the treatment

* Journal of Nervous and Mental Diseases, 1885.

of hyperæsthetic cases vibration of long duration is indicated.

When applying compressing interrupted vibration to the abdomen, during each forced expiration carry the vibratode more and more deeply and allow for short intervals of rest, few in number.

By vibratory stroking is designated lightly touching a part of the body with a vibratode and at the same time moving it over the surface in indicated directions.

When about to apply vibratory stroking the operator should test the speed, rate, and stroke by placing the vibratode on the side of his own cheek or forehead and lightly stroking the parts. When it produces a soothing, agreeable sensation the conditions will be right for making an administration. The stroke should be as short as possible, the speed fairly rapid, but not so rapid as to produce stimulation. For this form of administration a soft rubber vibratode, particularly the rubber covered disc or soft rubber cup shaped vibratode is preferable. The writer has applied it very successfully in the treatment of headache, and has noted that in this condition the stroke should be made rather slowly and with a very careful touch. It may be applied many times over the same place, the effects sought determining the duration. The touch should be very light in order that a sense of friction is not produced—a soothing effect being desired. It may also be applied for reflex effects to areas of the skin, stimulation of which, by massage, was first advocated by Kellogg for the purpose of reflexly stimulating the spinal centers with the object of affecting not only the mus-

cles, but the internal organs as well, and also to increase secretory, excretory and vascular activity.

According to Starr the segmental localization of muscular reflex acts is as follows:

Segment	*Reflex Act.**
4C to 1D	Pupillary reflex. Pupil dilates when neck irritated.
5C to 1D	Scapular reflex. Contraction of scapular muscles when skin over scapula is irritated.
5C to 6C	Biceps and supinator longus. Flexion of the forearm when their tendons are tapped.
6C	Triceps reflex. Extension of forearm when tendon tapped.
7C	Scapulohumeral reflex. Adduction of arm when inner lower edge of scapula tapped.
6C to 8C	Extension of hand when extensor tendons at wrist tapped.
7C to 8C	Flexion of hand when flexor tendons at wrist tapped.
8C to 1D	Palmer reflex. Finger clonus caused by stroking palm.
9D to 12 D	Abdominal reflex. Retraction when side of abdomen stroked.
1L to 3L	Genital reflex. Contraction of abdominal muscles when testicle squeezed.
2L and 3L	Patella tendon. Knee-jerk when tendon at knee struck.
1S to 3S	Foot clonus. Flexion of ankle due to extension of Achilles tendon.
1S to 3S	Plantar reflex. Flexion of toes or extension of great toe and flexion of others when sole of foot tickled.

*Starr. Organic Nervous Diseases, page 180.

Kellogg* also adds the thoracic at the sides of the thorax " between the fourth and fifth ribs."

It must be remembered when the chain, consisting of the centripetal nerve carrying the message, the anterior horn of the spinal cord and the motor nerve is broken, the reflexes are accordingly affected, being absent or lessened in degree. The *stimulus to produce a reflex* action must be *stronger* than one required for *stimulation of the motor nerve* directly, and the stimulation of " the *specific end-organ of the afferent nerve" produces more easily a more complex reflex movement* than stimulation of its trunk (Hall).†

*Kellogg. Art of Massage.

† Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 809.

PLATE IV.—Administration of Vibratory Stroking.

Plantar stroking is indicated in cases characterized by loss of tone of the legs; *cremasteric and gluteal* stroking in rectal or vesical atony; abdominal stroking for relaxed walls of constipation, and lack of tone; and *interscapular* stroking in certain cases of anæmia. In general, vibratory stroking is used where there is a lack of muscular tone in the area, to which stimulation of the reflexes induces contraction and increases the tone.

Vibratory stroking can be most effectively applied in respect to direction by observing the rules of stroking as used for massage which are as follows:

"Head—from before backward, starting at the center of the forehead and from above downward, starting at the vertex.

Back—from above downward, from the median line outward.

Chest—from the sides toward the median line.

Abdomen—upper part, from the sides inward and upward; middle part, toward the median line; lower part, from below upward and inward.

Arms—from the shoulders toward the hands.

Legs—from the hips downward.

Feet—from the toes toward the heel."

Stroking is generally directed against the venous flow, but may be applied in any direction indicated in the case.

Vibratory friction applied with moderate pressure is of more value than is generally recognized. It is applied by moving the vibratode over a part of the body with varying degrees of pressure suited to the particular part or condition under treatment. Winternitz demonstrated that friction by hand power increased the excretion of moisture 60 per

cent., and dissipated heat more than 95 per cent. and in some cases increased heat elimination 95 per cent.

When applying vibratory friction the vibratode should be moved rapidly over the surface, and since superficial effects only are sought, such as its effects on the circulatory system and lymphatics, a light, or between a light and a moderate pressure, will be required. A fairly short stroke (one suited to the part treated) and a fairly rapid rate of speed are also essential features of this method of application. If the skin is delicate or moist a little talcum powder dusted over the surface to be treated before applying the vibratory friction will assist in diminishing the friction irritation, but it is seldom necessary. A rubber covered disc vibratode is preferable for the administration of this method.

Vibratory friction may be applied to meet different indications, *centripetally,* toward the heart, *centrifugally,* away from the heart, and in a *circular* direction. If the direction be centripetal, follow the course of the large veins particularly, i. e., the course of the median on the median line of the anterior surface of the forearm, and the ulnar along the inner border of the forearms both anteriorly and posteriorly, the basilic on the inner and the cephalic on the outer side of the arms.

Centripetal vibratory friction increases the flow of lymph, blood and chyle, and assists absorption, whereas centrifugal vibratory friction tends to lessen such activity, and is used to produce soothing and derivative effects on organs, as relieving œdema. If the chest be treated, let the direction be from the sternum on either side toward the axillary space; and

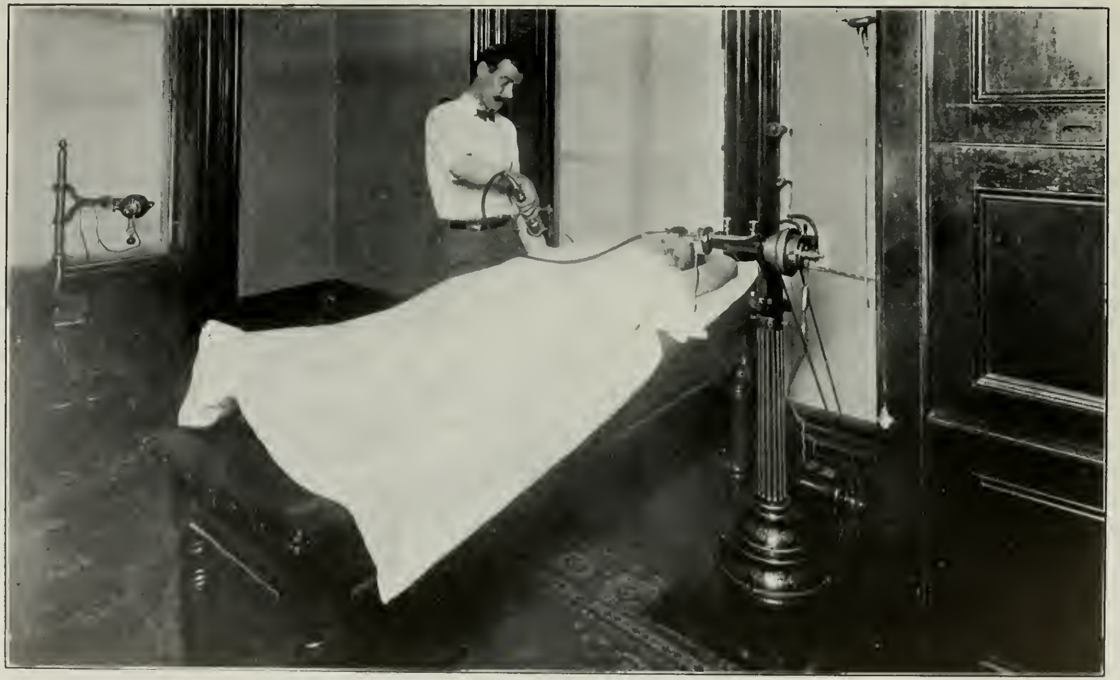


PLATE V.—Administration of Vibratory Friction.

in case of the abdomen from the median line down and out, and in some cases circular, the umbilicus being taken as the center. Vibratory friction centripetally over the parts between the affected portion and the heart is indicated in swelling, dropsy, gout, rheumatism, sprains, sciatica, etc. If the inflammation be local, vibra-massage should be applied particularly between the site and the heart.

Headache may sometimes be relieved by the application of vibratory friction of the spine, thus affecting the vaso-motors. Pelvic pain may often be relieved by applying vibratory friction over the lumbar and sacral regions.

Centripetal vibratory friction may be applied to the *head* from the median line backward, downward, and outward to the line of the middle, or inferior cervical region. When applying it to the *neck* anteriorly follow the line of the vessels from above downward. When applying it to the *hand* and the *arm* for producing other than the lightest superficial penetration, a little less than medium stroke is to be preferred with moderate pressure, and a medium rate of speed. The patient should lie upon the table, at first face downward, resting his hand and arm on the arm-rest, or lightly on the palmar surface of an assistant's hand, while with the other the assistant should support the patient's elbow, the hand being held higher than the elbow. Treatment should be given with the patient's arm perfectly relaxed, else the muscular tension will oppose the effect sought. Apply the vibratode five or six times, beginning at the finger tips, particularly in the intermetacarpal spaces and extending it to the wrist. To the wrist, in most cases, also apply deep interrupted vibration with

moderate pressure in the usual manner, the operator supporting the wrist with his left hand. Then, with the patient lying on his back with the arm supported on an arm-rest or an assistant holding the hand elevated as before, make the application to the palmar surface of the hand and arm, applying deep interrupted vibration with moderate pressure in the palm, and about the wrist for the purpose of reflexly inducing greater circulatory activity. The *fore-arm* should be treated from the wrist to the elbow, posteriorly and anteriorly, the vibratode being moved rapidly over the surface following the course of the ulnar, the median and the radial veins. Then apply deep interrupted vibration to the elbow joint it being supported by the operator's left hand. This should be followed by vibratory friction of the arm from the elbow to the shoulder, and interrupted vibratory treatment of the axillary glands. The treatment is usually not continued longer than for seven or eight minutes to an arm. In applying it to the *lower extremities* proceed from the toes to the heel, then from the toes to the ankle, using deep interrupted vibration with moderate or heavy pressure, according to the thickness of the foot, under the arch of the foot and about the ankle. In applying it to the *leg,* the patient should lie face downward with leg flexed on the thigh and supported by an assistant. Apply then vibratory friction posteriorly, first from the ankle to the popliteal space four or five times, moving over the surface following the course of the veins; then anteriorly. Then use interrupted vibration at the knee joint two or three times in the depressions about the joint. The thigh should be given a vibratory frictional treatment posteriorly and

anteriorly, then apply deep interrupted vibration to the groin. When used to lessen œdema of the arm, apply deep interrupted vibration to the axillary glands, then vibratory friction from the elbow toward the axilla. Deep interrupted vibration of the elbow joint should follow. Vibratory friction centripetally should then be applied to the forearm, followed by deep interrupted vibration to the wrist joint. The hand should then be treated with vibratory friction. A similar plan should be followed for œdema of the legs and thigh.

VIBRATORY FRICTION TO THE NECK should be applied from the space between the angle of the jaw and the mastoid process downward and inward to the lower border of the neck, and then outward to the shoulders after which apply extremely superficial interrupted vibration on each side of the larynx. Posteriorly employ vibratory friction from the occipital protuberance over the neck downward and outward. It is desirable to have the patient lie face downward at first and then on her back and allow a few minutes' interval of rest between these applications. A medium stroke is preferred.

When applying VIBRATORY FRICTION TO THE CHEST the patient should lie with the arms upon the arm rests of the table the inclination of which will depend upon indications. Apply the vibratode from the insertion of the pectorals toward the sternum three or four times and then below the pectoral muscles, vibrating from the sternum out and around to the axilla following the course of the ribs.

VIBRATORY FRICTION IN THE CIRCULAR AND CENTRIPETAL DIRECTIONS should be applied with fairly deep pressure when application is made to the hip. *Cir-*

cular friction is first employed and then centripetal, forward along the iliac muscle from the great trochanter.

When applied to the *back* begin at the occiput and follow each side of the spinal column to the pelvis, then apply friction from above downward, the vibratory circular friction to be employed with moderate pressure above the scapulæ. *Below the scapulae* follow the ribs from without inward toward the spine. Then use deep interrupted vibration with moderate pressure from above downward alternately on each side of the spinal column making the applications between the transverse processes three or four times to each site. Care must be exercised that the pressure is not too heavily applied lest pain and tenderness follow. As demonstrated by Professor Maggiora the duration of an application is an important consideration requiring an exercise of care lest it be too long. *Vibratory friction* is applicable to inflammatory conditions and œdemas. In such cases begin the friction at the part nearest the trunk and gradually approach the distal part affected *always working toward the trunk.*

THE APPLICATION OF FRICTION is best based upon methods in use for years by scientific masseurs.

"(1) Head—from before backward and above downward.

(2) Neck—downward.

(3) Back—above shoulder blades circular; from shoulder blades to sacrum down; in the region of the loins, from the sides toward the spine.

(4) Hips—circular.

(5) Chest—from the sternum toward the axilla.

(6) Abdomen—upper part, from above down-

ward, and outward; lower part, from the median line downward and outward.

(7) Arms and legs—from below upward."

In cases of œdema of the arms vibrate the axilla then start at the inside of arm and proceed up, at the same time gradually approaching the hand. Apply interrupted vibration at each joint as it is reached.

"(8) Hands—from the finger tips to the wrist, dorsum first.

(9) Feet—from toes to the heel on dorsum first then from toes to the heel and instep alternately."

In oedema of legs apply interrupted vibration to the inguinal glands. Then commence at inner side of thigh and proceed up, at the same time gradually approaching the foot. Apply interrupted vibration to each joint as it is reached.

"(10) Face—from the median line of the forehead outward to the temples, then downward toward the chin."

For general vibratory treatment the patient should be clad in a loose robe and all parts except that to be treated should be covered. The order preferred is that used in general massage,—"(1) Arms, (2) chest, (3) legs, (4) abdomen, (5) hips, (6) back, (7) head, (8) neck." General treatment is very rarely indicated and when used should be exceedingly short, the vibratory frictional treatment being the one best suited for the purpose.

Vibratory rolling, the last modality, is applied by using the ball or roller vibratode to roll backward and forward over a part with varying degrees of pressure, moderate particularly, to stimulate functional activity especially of the skin. If the arm

is to be treated roll the parts on the underlying structures to and from the shoulders gradually approaching the elbow and in like manner from the elbow toward the hand. The stroke should be in accordance with the indications, and the rolling should be rapid but the speed medium. When manual massage is used centripetal friction followed by the rolling has been found useful. It favors the production of heat and stimulates cellular activities.

The above includes forms of application to which modern vibrators of different types of independent motion may be adapted. A growing demand will eventually bring forth more perfect machines as new features are suggested by skillful clinicians. It seems probable however that the skill and technique of the hand united with the never tiring power employed with modern appliances under the absolute control and guidance of the skilled operator, is certain to accomplish more easily and with better results the otherwise laborious task of the masseur, the degree of touch as a factor sacrificed in mechanical vibratory work being dependent on the operator's individuality of touch transmission.

A good rule to follow is that of scientific massage. "All of the single or combined procedures should be begun moderately, gradually increased in force and frequency to the fullest extent desirable, and should end gradually as begun." Vibration can be used to advantage oftentimes in connection with electricity, hydrotherapy, phototherapy, and exercise,—passive or active, assistive or resistive. If the part treated be motionless and exercise is indicated, prescribe passive motion. If there be slight but not complete motion use assistive movements, if a super-

fluity of motion resistive movements are indicated, but care must be taken not to strain the part. The motions should be slowly and regularly executed, and each movement should be followed by a short interval of rest. It is also necessary that the exercises be taken daily. When dizziness, palpitation of the heart, pain in the chest, very rapid breathing or any other difficulty follows the exercises, they should be modified, possibly changed, or even omitted for a time until the powers of the patient warrant a continuance. There should always be an interval between the time of exercise and the meal preceding as well as the meal following.

CHAPTER V

General Physiological Effects of Mechanical Vibration

Massage and mechano-exercise have been investigated for many years, and of late vibration, manual and mechanical, has received attention. As certain facts and principles have been considered by Ling, Maggiora, Colombo, Mezger, Sargent, Kellgren, Cyriax, Savage, Taylor, Graham, Kellogg, Fleisch, v. Marxow, Buchheim, Saquet, Meltzer, Lagrange, Bechterew and Tschigajew, Langendorff, Axenfeld, Lange, Mesnard, Lavalette, Hasebroek, Winternitz, Kumpf, Ewer, Bjorkstén, Zander, Abrams, Ledermann, Nebel, Granville, Charcot, and others, it is fitting to recognize their efforts. Beginning with the work heretofore accomplished, it will be possible to approach a more complete system. For a full appreciation of the subject it is necessary to recall certain anatomical and physiological data.

Mechanical vibration when applied in accordance with varying rapidity of speed, length of stroke, degree of pressure—light, moderate or heavy—is capable of affecting every tissue and organ in the body, with varying degrees of intensity. The effects may be classified as follows:

1. Mechanical—It induces the removal of extravasations, lymph, exudations and transudations, breaks up adhesions and stimulates the circulatory and lymphatic systems. It improves respiration, stimulates excretion and secretion, relaxes over contracted parts, and contracts relaxed parts.

2. Chemical—It assists in the interchange of oxygen and CO_2 and in the increase of certain waste products such as sarcolactic acid.

3. Thermal—It causes the generation of heat; vibratory friction increases heat elimination, and deep interrupted vibration with moderate or heavy pressure by acting on muscles increases heat production. Cutaneous and vaso-motor stimulation affect the storage of heat, for contraction of the skin and its blood-vessels diminishes the heat evolved. If they dilate it is increased. If stimulation* of sensory nerves causes the circulation to be accelerated, the respiration to be increased, the skeletal muscles to be relaxed, " the temperature of the interior of the body and rectum is increased." If stimulation of sensory nerves causes the circulation to be retarded, respiration to be decreased, and the skeletal muscles to be contracted reflexly, " the temperature of the interior of the body and rectum is diminished." "External† parts give off more heat than they produce, so that they become cooler the more slowly new blood flows into them, and warmer the greater the rapidity of the blood stream through them." The temperature of internal parts falls " when the blood stream through them is accelerated and it is raised when the blood stream is retarded." An increased temperature means an increase in the number of heart beats, according to Liebermeister.‡

*Landois and Stirling. Text Book of Human Physiology, 4th edition, page 410.

† Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 411.

‡ Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 419.

" Pulse beats per minute.......	78.6	91.2	99.8	108.5	110	137.5
Temperature in C..........	37°	38°	39°	40°	41°	42°."

4. PHYSICAL—It assists endosmosis of the lymphatics and the physical action of respiration.

5. METABOLIC—It induces anabolic or katabolic changes affecting the functional activity of a part as in the removal of stasis and an increase in the nutrition of a poorly nourished muscle.

6. REFLEX—It induces activities and changes in related parts through the nerve stimulation of the central and peripheral parts of the cerebro-spinal and sympathetic systems, as in its action as a sedative.

The following, by Taylor,* is of interest: " The analysis of transmitted motion into its factors, and the discrimination of the separate, distinct effects of these, is of direct consequence for estimating the influence of different rates of rhythm or length of motion-waves transmitted.

" We may presume that the heat evolved must pretty closely correspond with the rectilinear extent of the motion and the accompanying pressure whatsoever the length of the waves. On the other hand, the chemical products are in proportion to the number of changes of direction into which this imaginary direct line of motion is broken up, for every concussion which accompanies change of direction throws off energy in the chemical form, doubtless increasing the oxidation and other chemical changes to which all constituents of the organism are by

* Taylor. Massage.

nature destined, and the promotion of which all curative processes must include.

"But the evidences derived from chemical analogies and chemical facts are by no means the conclusion of the array available. Those ordinarily satisfactory are abundant. These are clinical tests. The peculiarity of this class of evidence of chemical effects consists in removing obstinate local and general manifestations of disease, for which the most potent chemical remedies are commonly employed with far less conclusive success. This effect of rapid wave or vibratory motion shows that profound chemical changes are superinduced by the means used, which in this case can only be liberation of chemical energy in contact with material having unstable equilibrium—the non-vital suboxides."

The effects of mechanical vibration are as follows:

1. Cardiac activity is regulated. Blood pressure may be lowered reflexly. It may be raised also.

2. Contracts arterial blood vessels. If prolonged, dilatation results. Pulse rate may be lowered.

3. It induces many reflex effects as well as motor, sensory, secretory and vaso-motor effects. It lessens and removes hyperactivity of nerves. It diminishes pain and relieves congestion not due to organic conditions.

4. Diminishes and relieves muscular pain and stiffness. It can relax tense muscles and cause relaxed and atrophied muscles to become firm and increase in size. It tones up cardiac muscles.

5. Reflexly induces contraction of the lungs. Relieves pain and dyspnoea. Improves respiration.

6. Diminishes size of glands, directly and reflexly.

7. Contracts or dilates the liver, stomach and spleen.

8. Diminishes irritability of the bladder when not due to organic conditions.

9. Induces peristalsis.

10. Increases or diminishes lymphatic circulation according to the vibratory friction given, centripetal or centrifugal.

11. Assists in diminishing intraocular tension.

12. Lessens nasal hyperemia.

13. Suction vibrations are valuable in removing pus from a boil, etc.

Vibration, having a marked effect on respiration, digestion, absorption, heat, secretion, excretion, the nervous system, the muscular system and all physiological processes which are affected by active change, it is necessary that the anatomical relations, the physiological function, the blood, nerve and lymph supply of each organ or part of the human body be thoroughly understood in order to more fully appreciate faulty technique, for too often vibratory work is misdirected, energy is misspent, and mechanovibration or the particular vibrator used, is condemned.

The physiological effect of vibration, according to Reich, is to increase " the excitability as well in the motor as in the sensory nerves if the excitation continues for a short period, but to lessen the excitability if the time given for the vibration or concussion is prolonged. Therefore we have reason to believe that small excitations of long duration have the same effect upon the nerves as strong applications which only work once, according to Pflüger-Arndt's law.

The skin will be pale after a short application of vibration (high frequency), but will redden after a longer application. Therefore a contraction will be at the beginning sometimes even contraction of muscles of the skin, while vaso-dilatation will ensue in the further application." He believes that general vibration increases the blood pressure, accelerates the circulation, increases absorption and the secretory power of glands. Mechanically it can favor the expulsion of gall and kidney stones. Reflexly when vibration is applied " in the region of the roots of the spinal cord, especially of the neck a general sense of cold results." The writer has noted this when the vibratode is applied over the exit of the second cervical nerve. If applied to the spinal cord in the interscapular region a decrease in heart rhythm ensues. " Manipulations of short duration will have a stimulating and tonic effect while prolonged vibration will have a quieting, analgesic, sedative effect; therefore use short but often repeated vibrations in cases of paresis, cutaneous anæsthesia and when used as an analgesic.

" In relaxations of contractile tissue, in weakness of the heart, in floating kidney, in relaxations of the uterus, in hemorrhoids and prostatic hypertrophy, for the sensations of lassitude of neurasthenic patients—in all these conditions use short but often repeated vibration.

" The prolonged vibration should be used in neuralgia, hyperæsthesia, spasms, tremor, paralysis agitans, insomnia and all conditions of general excitability. Also use prolonged vibration for the mechanical effect; for instance, for the expulsion of kidney and gall stones. Sometimes the treatment may be

given for as long a period as one-half hour." (Reich.)

Throughout this work the word "*vibration*" is used to include vibration of all frequencies. Some writers prefer to call vibration of low frequency "concussion."

THE FOLLOWING DEDUCTIONS WHEN SPINAL CONCUSSION or vibration was employed, have been noted by Abrams* and the author.

1. Contraction of the myocardium associated with the heart reflex of contraction. It increases pulse volume and diminishes frequency.

2. If the heart is weak and blood-pressure is high, a strengthening of the heart will cause fall of pressure by vibration of 7th cervical spine. Concussion properly applied can cause fall of blood pressure. Vaso dilators in drugs reduce blood-pressure by "paralyzing the vaso-constrictor mechanism."

3. If the heart is weak and vaso-motors do not "compensate the failing heart," a strengthening of the heart causes rise of blood pressure by vibration of 7th cervical spine. Concussion selectively applied can raise blood pressure.

4. Heart reflex of dilatation increases area of cardiac dullness associated with no increase in diameters of heart as "heart muscle can increase the size of its cavities without any corresponding augmentation of tension of its walls."

5. The aortic reflex of contraction is associated with stimulation "of the vaso-constrictor nerves or their centers in the cord. They emerge with the anterior roots as preganglionic sympathetic fibres."

6. The aortic reflex of dilatation is associated with

*Abrams. "Spondylotherapy."

stimulation of the vaso-dilator nerves or their centers in the cord. They emerge with the posterior spinal nerves.

7. Stimulation of the longitudinal muscular fibres of intestine occurs in intestinal reflex of dilatation.

8. Induction of contraction of circular fibres occurs in intestinal reflex of contraction.

9. The excretion of indican is promoted after 15 minutes' concussion of first three lumbar vertebrae or corresponding intervertebral vibration between the 1st and 2nd and 2nd and 3rd lumbar vertebrae.

10. An increase in volume of liver occurs in liver reflex of dilatation by concussion of 11th dorsal vertebra.

11. Depletion of liver induced by liver reflex of contraction.

12. It augments the tone of the splanchnic vasomotor mechanism by expressing the blood from the abdominal vessels to the right heart, by concussion of the spines of 2nd, 3rd, 4th, 5th, 6th, 7th and 8th dorsal vertebrae which correspond to splanchnic nerves from the 5th, 6th, 7th, 8th, 9th, 10th, 11th and 12th dorsal nerves or by corresponding intervertebral vibration.

13. It has a mechanical effect on the spleen by concussion of first three lumbar spines or corresponding intervertebral vibration causing a reflex contraction of the spleen.

14. It induces dilatation as well as contraction of kidney thus varying its volume which depends on structural distension and amount of lymph, and blood in its vessels.

15. Concussion or vibration "stimulates the

motor component of a spinal segment and subdues its sensory constituent."

The effect of vibration has been appreciated for a long time, as noted by Snow in his work, "Static Electricity and the Uses of the Roentgen Ray," as follows:

"The action upon metabolism of vibratory influences has long been recognized by physiologists such as that attributed to the heart's impulse. Dubois-Reymond taught 'That the nutritional effects depend not on the quantity of the electricity but upon the *variations* in the quantity, and the suddenness of these variations,'" which is true as applied to vibration, but requires qualification in various features of administration.

1. The vibration should possess the necessary rapidity and length of stroke. Exerted pressure should be painless or according to tolerance.

2. The rapidity, stroke, pressure or non-pressure should be governed by the indications and the patient's reactionary resistance.

3. The interruptions when using interrupted vibration should be limited in number to avoid exhaustion in nerve power.

4. The intervals of rest should be as long or twice as long as the period of impulse contact to assist in the perpetuity and fixedness of the effect.

5. The stroke should be adapted to the density of the part treated, and the speed to the condition.

6. Vibratory effects should be applied to aid or promote functional activity of a part without altering the integrity or unfavorably affecting the normal activity of the part.

7. The effect directly or indirectly will vary with

the duration, speed, direction and pressure used in the treatment.

Cyriax* summarized an exhaustive study of the effect of vibration in which he considered both manual and mechanical vibration. The following is a brief summary of his observations.

" The great majority of the conclusions quoted are obtained from experiments with machine vibrations."

1. " EFFECT ON THE CELLS of the human body. Fleisch V. Marxow set up the theory that the (vibrations) minute shocks imparted to the cells of the lungs by the heart beat were necessary for the gaseous interchange, that these were in fact a *sine qua non* for actual existence. Other observers have concurred in this.

2. " EFFECT ON BACILLI. Saquet found no change in the growth and characteristics of bacilli after eight days' continued vibration, whereas Meltzer found destructive effect with shorter time of vibration.

3. " EFFECT ON THE TEMPERATURE. Taylor, Lagrange, Saquet found a rise of temperature after using vibrating machines. Bechterew and Tschigajew, using vibration of the whole body, found a rise in the internal temperature and a fall in the skin and axillary temperatures.

4. " RELATION BETWEEN SPEED AND EFFECT. Langendorff, using a tuning fork on a nerve, found the maximum result with 4800 oscillations per minute. Axenfeld with the same kind of apparatus considered that up to a certain point the slower the rate the

*Cyriax: "Vibrations and Their Effects." Lecture given before the Ling Association, London, on Jan. 5, 1906, by Edgar F. Cyriax, M. D., G. D.

better, as the amplitude of the movements of the tuning fork was then greater. Lange concluded that a rate of 1100 to 1200 per minute produced the greatest effect." Mesnard caused muscular tetanus with 15,000 vibrations per minute.

5. ON THE MUSCLES. Muscular contraction was induced. (Rood, Lavalette.) Mesnard used "very rapid vibrations" to cause contractions. Ewer "states that vibrations can sometimes cause contraction in muscles which will not react to electrical stimuli."

6. ON THE HEART. It diminishes excited cardiac action (Winternitz, Levin, Hasebroek, Nebel, Ziegelroth). "Achert and Siegfried found very little effect, and Bechterew and Tschigajew a varying one. Heitler found that vibration of the heart set up by the so called hacking over it raised the tone of the cardiac muscle and diminished the size of the organ. A strong manual vibration on the heart is one of the best methods of causing it to beat again" when the heart ceases to beat (Strassmann, Korte and Kumpf). Some consider that heart vibration acts reflexly and others that it acts directly. On the blood vessels it causes contraction and rise of blood-pressure according to Björksten, Zander, Bechterew, and Colombo, which according to some is followed by a dilatation and fall of blood pressure. The writer finds that it may raise or lower blood-pressure.

7. EFFECTS ON NERVES. Bechterew and Tschigajew by vibrating the whole body induced sleepiness in about a quarter of an hour. The vibrating casque of Charcot has been extensively used in France to promote sleep. Vibration diminishes pain. "Buchheim obtained stimulatory effects on the sympathetic

and vagus in the neck according to the site of application."

8. IT IMPROVES RESPIRATION (Hasebrock).

9. GLANDULAR CONSTITUENTS, solid and liquid, of liver, stomach, etc., are increased by "a combination of petrissage, friction and vibration." (Colombo.)

10. IT PROBABLY INCREASES OR DIMINISHES THE FLOW OF LYMPH according to the direction of the running vibrations used,—centripetal or centrifugal.

11. CONTRACTIONS OF UTERUS. (Kumpf.)

12. CONTRACTIONS OF OESOPHAGUS. (Lange.)

Cyriax has probably compiled the most exhaustive summary extant on the effects of the Kellgren method of manual vibration. The same effects have been verified in many instances by the writer with mechanical vibration.

CHAPTER VI

Mechanical Vibration in Diagnosis

In the past, interpretation of the patient's symptoms depended principally on inspection, percussion, auscultation, palpation, mensuration, the thermometer, the ophthalmoscope, the laryngoscope, the speculum and the laboratory with its elaborate outfits, chemically and microscopically. The present has developed the endoscope, the x-ray, sphygmomanometer, radium and other radio-active substances, scientific electro-therapy, scientific manual treatment by the methods of Kellgren and Cyriax, and spondylotherapy as so well expounded by Abrams in which is properly included *mechanical vibration,* all of which have broadened the field of diagnosis as well as that of treatment.

As one of the aids to diagnosis the mechanical vibrator should have a place in every physician's office for humanity demands that those who hold life in the balance should be progressive and acquaint themselves with all the aids that progressive science brings.

Mechanical vibration determines the following:

1. The presence and site of inflammation and pain.

2. The degree of tissue irritability as of nerve, muscle, organ or skin.

3. The presence and degree of muscular spasm in a region or part.

4. The range of mobility of a joint by the induction of lessened tension.

5. The state and degree of efficiency in respect to various reflex functions of nerves as cardiomotor, etc.

Probably the greatest field for mechanical vibration in the realm of diagnosis is that of the spinal nerves.

A CAREFUL EXAMINATION OF THE BACK will show signs of a disordered nervous mechanism. Arnold* found in all cases of chronic disease examined by him that "there had been disturbances of the nervous mechanism of the disordered part, usually dependent upon a deficient tonus of its blood vessels which is the result of a deficient blood supply to the segments of the spinal cord from which the vasomotor nerves arise." In examining the back he considered the following:

Patient sitting, with hands placed symmetrically on knees.	*Normally.* Symmetrical. Right side may be more developed. Spinous processes will be in a vertical line. No "prominent or depressed spinous processes aside from those normally found in the two anterior and two posterior curves in the spinal column." The spinal processes do not tend to abnormal separation which would be caused by "relaxed ligaments or disturbances of the erector spinae group of muscles." No atrophied muscles.
Patient recumbent on right side, head slightly elevated, operator facing patient and examining left side of the vertebral column.	*Normally.* No tenderness. No contracted muscle fibres or muscles.
Patient recumbent on left side, head slightly elevated, operator facing patient and examining right side of the vertebral column.	*Normally.* No tenderness. No contracted muscle fibres or muscles.

* Arnold. "The Importance of the Physical Examination of the Back in General Diagnosis." *Medical News,* March 18, 1905.

Patient in dorsal position, head being on same level as the trunk. Examine neck muscles.	*Normally.* Muscles smooth, painless to moderate pressure, and elastic.

Pathological conditions cause muscular atrophy, contractions of the muscle fibres or muscles en masse and the relaxation of interspinous ligaments resulting in "prominence or depression of one or more spinous processes." These results are to be found "in the region of the posterior primary divisions of the spinal nerves which arise from the segment or segments of the cord which supplies or supply the organ or part affected," in consequence of which a knowledge of segmental localization, which will be considered later, is essential.

An examination of the spine made by inspection and palpation is then in order. The patient should be examined walking, standing and lying, prone and supine. The plan of Goldthwait, Painter and Osgood is recommended. It is as follows:

Inspection	Attitude. Motion,—limitation of and location. Stiffness. Deformity. Bony deformities may be sharp, angular or rounded. Swelling. Spasm. Respiration.
Palpation	Muscular spasm. Swelling, character and location of. Tenderness.

The normal curve is a lumbar lordosis and a dorsal kyphosis. This curve is altered by disease. There may be present an antero-posterior or a lateral curvature. Lateral deviation* without compensatory S-shaped curve usually comes from a

* Goldthwait, Painter and Osgood. Diseases of the Bones and Joints, page 49.

cause external to the spinal column such as trouble in the sacro-iliac joints or below them, or from pelvic or abdominal irritations. When the trunk is prominent on one side rotation of the vertebrae on their long axis has occurred as a rule.

"ROTATION OF THE BODIES OF THE VERTEBRAE on a vertical axis," says Warren-Gould* "always accompanies and is a necessary consequence of the lateral deviation. The bodies face round toward the convexity, while the spines are directed toward the concavity, so that the deviation of the spinous processes does not represent the full lateral curvature. As a result of the rotary movement, the transverse processes on the side of the convexity are directed posteriorly, carrying with them in the dorsal region, the ribs, the angles of which become very prominent. In the upper dorsal region the scapula will be pushed farther than normal from the midline. The shoulder on the side of the convexity will be elevated, and this is frequently the first sign noticed by the patient. * * * On the side of the concavity the capacity of the chest is much diminished, the ribs being crowded together, whilst the breast is sometimes noted as more prominent than on the opposite site."

DEVIATIONS AND DEFORMITIES below the cervical region may be caused by pleurisy, intra-thoracic growths, aneurysms, emphysema, trauma or suppurative or non-suppurative processes. They call for a chest examination. Intra- and retro-peritoneal aneurysms, or diseased viscus may result in spinal postural or structural deformity.† If the scapula of

* International Text-Book of Surgery. Vol. I, page 846.

† Goldthwait, Painter and Osgood. Diseases of the Bones and Joints, page 51.

either side projects it means "paralysis of the serratus magnum of that side" or lateral curvature; if the left scapula project it may possibly mean aneurysm of the arch of the aorta.* Hysterical patients may show a lateral spinal deviation which disappears in the recumbent position.† Conditions in other spinal diseases should be considered, such as acute osteomyelitis, concussion, after effects of traumatism, sprains or dislocations. The functions of the cord are not generally affected by lateral curvature.

This examination should be followed by a CONSIDERATION OF THE VERTEBRAE, their situation, singly, and relatively, and their relation to the spinal nerves and segments so as to correctly interpret the vertebral tenderness or associated pain elicited by means of the vibrator.

THE SPINOUS PROCESSES are best located by having the patient fold his arms and lean forward or by rubbing the spine when the processes will become reddened.

The following tables are inserted for the operator's convenience.‡

Spine of Vertebrae.	
2nd c.	Felt in the pit of the neck by deep pressure.
6th c.	
7th c. (vertebrae prominens)	
1st d.	
2nd d.	Corresponds with head of 3rd rib.
3rd d.	Level with commencement of spine of scapula. Corresponds with head of 4th rib. Root of spine of scapula marked by a dimple.

* Butler. Diagnostics of Internal Medicine, page 284.
† Abrams. Spondylotherapy, page 45.
‡ Gray's Anatomy, pages 1037, 1038.

4th d. 5th d. 6th d. 7th d. 8th d. 9th d.	Correspond with heads of ribs whose number is the number of vertebra plus one, as head of 5th rib, 6th, 7th, 8th, 9th and 10th.
7th d.	Level with inferior angle of scapula.
11th d.	Corresponds with head of 11th rib.
12th d.	Corresponds with head of last rib.
4th l.	Highest part of ilium.

A comparative table with reference to organs is also of use occasionally.

TABULAR PLAN OF PARTS OPPOSITE THE SPINES OF THE VERTEBRAE (GRAY)

Cervical	5th.	Cricoid cartilage. Oesophagus begins.
	7th.	Apex of lung: higher in the female than in the male.
Dorsal	1st.	
	2nd.	
	3rd.	Aorta reaches spine. Apex of lower lobe of lung. Angle of bifurcation of trachea.
	4th.	Aortic arch ends. Upper level of heart.
	5th.	
	6th.	
	7th.	
	8th.	Lower level of heart. Central tendon of diaphragm.
	9th.	Oesophagus and vena cava through diaphragm. Upper edge of spleen.
	10th.	Lower edge of lung. Liver comes to surface posteriorly. Cardiac orifice of stomach.
	11th.	Lower border of spleen. Renal capsule.
	12th.	Lowest part of pleura. Aorta through diaphragm. Pylorus.
Lumbar	1st.	Renal arteries. Pelvis of kidney.
	2nd.	Termination of spinal cord. Pancreas. Duodenum just below. Receptaculum chyli.
	3rd.	Umbilicus. Lower border of kidney.
	4th.	Division of aorta. Highest part of ilium.
	5th.	

A SPINAL EXAMINATION BY MECHANICAL VIBRATION should be employed to determine vertebral or intervertebral tenderness which may be local or reflex. Reflexly, disease of the cervical region may refer the pain to the upper limbs as the hand and arm in

hypertrophic types of osteoarthritis; diseases of the dorsal region to the chest or body as stomach disorders; disease of the dorso-lumbar region to the foot or leg, and diseases of the lumbar region to the lower limbs. In examining the spine if vertebral concussion is not employed, the following method is used. The ball vibratode is applied for a few seconds with a light, moderate or heavy pressure according to the tolerance of the patient in the intervertebral spaces, the patient lying face downward on a table affording a resisting surface. The arms being relaxed should hang downward on either side, in order to obtain a widened interscapular space, and to relax the muscles of the back.

The method of making such an application with the vibrator consists in placing the second and first finger tips of the left hand on two contiguous spinous processes and holding with the right hand the ball vibratode in the intervertebral spaces between, first on the right side, and then on the left side, raising the index finger of the left hand out of the way, the second finger of the left hand remaining in position. Then the first finger is replaced on the same spinous process as formerly. The second finger is then moved to the site occupied by the first just as the first is moved to seek the spinous process of the next vertebra. In this manner the spinous processes of the vertebrae are more easily found and are less liable to be passed over. The index finger and thumb of the left hand are thus ever ready to steady the vibratode or modify the severity of the vibration if necessary. The index and second finger of the left hand afford a sense of touch to act as a guide.

Plate VI.—Spinal Application.

Spinal vibration so applied determines the presence and sites of pain or tenderness, which oftimes are the causes, local or reflex, of the irritability of the spine, or reflexly of an associated part, as of viscero-motor or muscular reflexes. The vertebrae may be sensitive. In vibrating the lower part of the spine over the sacrum, the ball vibratode should always be steadied with the thumb and finger of the left hand or the vibrations modified to prevent an uncomfortable percussion, unless the patient is stout, when such procedure is unnecessary. If the parts be hypersensitive, a soft rubber cup-shaped vibratode, (7) in Fig. 26, may be used.

Vertebral tenderness may be elicited either by vibration directly over the spines or between the transverse processes of the vertebrae. Intervertebral tenderness elicited by vibration sometimes causes pain or contractions in a distant region or part similar to that from which the patient had suffered. Vertebral or intervertebral tenderness and its relation to conditions indicated by inspection, and palpation as affecting other parts, adjacent or peripheral or both, should be noted when inferences in regard to the findings should be carefully studied. These investigations will often determine an important differential diagnosis.

Abrams notes that not only will a downward pressure elicit vertebral tenderness, but "when the spine is pushed to one side or lifted, sensitiveness can be demonstrated." If sensitive places are found in the spine that correspond to the nerve supply of a viscus, the viscus should be vibrated with the disc to determine if it be sensitive also. Oftimes when the vibratode is on a sensitive spot in the administration

of spinal vibration, it will cause a spasm of muscles or of parts which when vibrated are found to be sensitive, indicating a local lesion.

In making such an examination the patient should lie in, as far as possible, a state of relaxation. If the head be turned with the patient facing to the right side, for example, and there is marked muscular tension of the muscles of the back, it is well to have him then turn his head to the other side to determine how much tension is due to position. Another point of importance is to determine the actual degree of sensitiveness present; for a superficial hypersensitiveness is a condition often found in neurotic conditions. This can be accomplished by a heavy vibration or by engaging the patient in conversation to make him less conscious of your work. The latter method is preferable. Under these circumstances a spot which at first seemed highly sensitive will show no tenderness whatever on vibrating it a second time. A table of reflexes is given in Chapter IV, page 72, and the subject of referred pain in Chapter XI will be of interest in the study of the causes and the interpretation of pain or reflexes elicited by mechanical vibration.

WHETHER A GIVEN SENSITIVE AREA IS REAL OR SIMULATED is determined by Abrams as follows:

"1. Mankopff's sign. Take the pulse rate before, during, and after pressure is made on the sensitive area. If the pulse becomes increased in frequency, it is a proof that the pain is genuine.

"2. Sign of Loewi. Dilatation of the pupil is in direct proportion to the intensity of the pain. Thus, if in a healthy man one exercises energetic pressure on the testicles, the pupil dilates, whereas in the

tabetic in whom the testicle is insensitive, no pupillary dilatation is observable.

"3. In neuroses the spine is not rigid at the points of sensitiveness."

VIBRATION AIDS IN DETERMINING A PROGNOSIS as well as in diagnosing a condition. If spinal vibration is applied to a patient complaining of pain in the hips, and spinal tenderness is found in the lumbar region it is not surprising to arouse pain in the crural and obturator nerves when vibration is applied as well as in the sciatic, and the prognosis cannot be so favorable owing to an indicated involvement in the pelvis and being less accessible for treatment. If there be no spinal tenderness, but tenderness is elicited over the sacro-sciatic notch and glutei muscles by the application of interrupted vibration with the disc vibratode employing moderate or deep pressure according to the patient's tolerance, a local neuritis will be interpreted. Goldthwait's sacro-iliac disease should also be considered if the diagnosis is not clearly defined.

THE ELICITATION OF PAIN in the crural and obturator is accomplished by the application of interrupted vibration over the points of exit in the groin. In some of these cases in which vibration with the rubber covered disc vibratode elicits pain in both hips, it will suggest pressure on the sacral nerves—an internal trouble as a fibroid tumor or prostatic enlargement,—and lead to a plevic examination. Interrupted vibration with the disc vibratode over the motor points of the thigh and leg muscles, or directly over the muscles, may reveal points of tenderness or tension. Spinal osteomyelitis may affect the lumbar, sacral or cervical region.

In brachial neuritis, an examination should be made of the cervical and interscapular region of the spine by vibrating with the ball vibratode in the regular way with fairly heavy pressure. The disc should after this be used interruptedly around and over the scapula, the posterior part of the neck, point of the shoulder, the anterior part of the shoulder, the arm, elbow, and the forearm to locate the painful sites. The elicitation of pain about the shoulder tells the operator where to place the metal electrode in applying the wave current, and the painful sites peripherally show where sparks should be applied. The painful sites in the spinal region and about the shoulder indicate where prolonged vibration will do good.

In hysterical patients interscapular vertebral tenderness is always present.

Visceral diseases* in some instances can be distinguished from intercostal neuralgia by the elicitation of *bilateral* vertebral tenderness on pressure, whereas in intercostal neuralgia there will be three points of tenderness—(1) vertebral usually unilateral, (2) sternal and (3) mid-axillary. Lumbar abdominal neuralgia may be distinguished from appendicitis by eliciting painful sites including "the vertebral exits of involved nerves" and eliminating appendicitis by "segmental analgesia" obtained by freezing.†

The existence of areas of vertebral tenderness associated with pseudo-conditions as pseudo-angina-pectoris, pseudo-oesophagismus, pseudo- neph-

* Abrams. Spondylotherapy, page 186.

† Abrams. Spondylotherapy, page 192.

rolithiasis, pseudo-dyspepsia, pseudo-cholelithiasis, and pseudo-mammary neoplasm was first called to the author's attention by Abrams. When there is an induration present in the breast, particularly in young people and it is difficult to make a diagnosis, apply the ball vibratode in the upper dorsal region—the 3rd and 4th interspaces—of the spine either directly over the spinous processes or in the intervertebral spaces. When the ball is used on the spinous process, the surface should first be dusted with talcum powder and the application of vibration or concussion be made over a thin pad of rubber. Sensation will be perceptible in the breast and the mass will become softened if due to tissue contraction. A direct application over the mass with a disc vibratode using a moderate rate of speed and very slight pressure will cause the mass to become still smaller, indicating that the trouble was a pseudo-mammary neoplasm probably due to contracted tissue, and was not an organized tumor.

THE NERVE SEGMENT CORRESPONDING TO THE NERVE INVOLVED in a pathological condition under consideration is revealed by the elicitation of vertebral tenderness as in a brachial neuritis sensitive spots may be found by spinal vibration as before described. These spots in cases of brachial neuritis have been found between the 1st, 2nd, 3rd and 4th dorsal vertebrae which correspond to the exit of certain spinal nerves as the 1st, 2nd and 3rd dorsal nerves. These nerves may have their origin from the 5th cervical vertebra to the 2nd dorsal spinous process. Vibration applied between the transverse processes of the 5th, 6th, 7th cervical and 1st dorsal vertebrae will pro-

duce a "concussion analgesia which may be palliative or curative in its effect." The following case will illustrate this point.

A housewife had suffered from brachial neuritis for nine years. At the time the vibratory treatment to be described was applied, she was suffering from some pain and lack of free movement. With the patient in a sitting posture, a spinal vibration with the ball vibratode applied for ten minutes, in two seances of five minutes each, was given over the spinous processes with a sheet of rubber intervening. It was applied to the 2nd, 3rd and 4th dorsal vertebrae, and in the corresponding intervertebral spaces. The pain elicited was greatest in the intervertebral spaces. These painful sites corresponded to the exits of the 2nd and 3rd dorsal nerves, which nerves may have their origins opposite the spines of the 6th and 7th cervical vertebrae. Vibration over the spinous processes of the vertebrae above mentioned, gave immediate relief; and a vibration over the intervertebral points of tenderness between the 2nd and 3rd, and 3rd and 4th dorsal vertebrae, gave a freedom of motion and relief from the pain heretofore unknown to the patient. Further investigation has led the author to vibrate in the intervertebral spaces indicated as it is more agreeable to the patient and easier for the operator.

The study of spinal segmental localization, considered in the light of the above, is essential in the diagnosis and rational treatment of certain pathological states.

There are 31 spinal segments corresponding to 31 pairs of spinal nerves, the *segment receiving its name from the nerve root* coming from it. These seg-

ments as previously stated, *do not correspond to the vertebrae bearing their names and numbers.* The study of the functions in the segments of the spinal cord comprehends their relation to the muscles, reflex acts, and skin sensation upon different areas.

SPINAL NERVES—THEIR SITES OF ORIGIN AND EXIT IN RELATION TO THE VERTEBRAE.

	Nerve	Root or Origin	Nerve	Exit of Nerve
CERVICAL SEGMENT*		A is highest, B lowest origin in six subjects (Reid, Morris' Anatomy, 3d ed.).		
	1 C	At level of foramen magnum.	I C	Between occiput and post. arch of atlas.
	2 C	A. A little above the posterior arch of the atlas. B. Midway between posterior arch of atlas and spine of axis.	II C	Between posterior arch of atlas and lamina of axis.
	3 C	A. A little below posterior arch of atlas. B. Junction of upper $\frac{2}{3}$ and lower $\frac{1}{3}$ of spine of axis.	III C	Between 2d and 3d cervical vertebrae.
	4 C	A. Just below upper border of spine of axis. B. Middle of spine of 3d cervical vertebra.	IV C	Between 3d and 4th cervical vertebrae.
	5 C	A. Just below lower border of spine of axis. B. Just below lower border of spine of 4th cervical vertebra.	V C	Between 4th and 5th cervical vertebrae.
	6 C	A. Lower border of spine of 3d cervical vertebra. B. Lower border of spine of 5th cervical vertebra.	VI C	Between 5th and 6th cervical vertebrae.
	7 C	A. Just below upper border of spine of 4th cervical vertebra. B. Just above lower border of spine of 6th cervical vertebra.	VII C	Between 6th and 7th cervical vertebrae.
	8 C	A. Upper border of spine of 5th cervical vertebra. B. Upper border of spine of 7th cervical vertebra.	VIII C	Between 7th cervical and 1st dorsal vertebrae.

* A spinal segment receives its name from the nerve root coming from it. It does *not* correspond to the vertebra of its name and number.

	Nerve	Root or Origin	Nerve	Exit of Nerve
DORSAL SEGMENT	1 T or D	A. Midway between spines of 5th and 6th cervical vertebrae. B. Junction of upper $\frac{2}{3}$ and lower $\frac{1}{3}$ of interval between 7th cervical and 1st thoracic vertebrae.	I D	Between 1st and 2d dorsal vertebrae.
	2 T or D	A. Lower border of spine of 6th cervical vertebra. B. Just above lower border of spine of 1st thoracic vertebra.	II D	Between 2d and 3d dorsal vertebrae.
	3 T or D	A. Just above middle of spine of 7th cervical vertebra. B. Lower border of spine of 2d thoracic vertebra.	III D	Between 3d and 4th dorsal vertebrae.
	4 T or D	A. Just below upper border of spine of 1st thoracic vertebra. B. Junction of upper $\frac{1}{3}$ and lower $\frac{2}{3}$ of spine of 3d thoracic vertebra.	IV D	Between 4th and 5th dorsal vertebrae.
	5 T or D	A. Upper border of spine of 2d thoracic vertebra. B. Junction of upper $\frac{1}{4}$ and lower $\frac{3}{4}$ of spine of 4th thoracic vertebra.	V D	Between 5th and 6th dorsal vertebrae.
	6 T or D	A. Lower border of spine of 2d thoracic vertebra. B. Just below upper border of spine of 5th thoracic vertebra.	VI D	Between 6th and 7th dorsal vertebrae.
	7 T or D	A. Junction of upper $\frac{1}{3}$ and lower $\frac{2}{3}$ of spine of 4th thoracic vertebra. B. Just above lower border of spine of 5th thoracic vertebra.	VII D	Between 7th and 8th dorsal vertebrae.
	8 T or D	A. Junction of upper $\frac{2}{3}$ and lower $\frac{1}{3}$ of interval between spines of 4th and 5th thoracic vertebrae. B. Junction of upper $\frac{1}{4}$ and lower $\frac{3}{4}$ of spine of 6th thoracic vertebra.	VIII D	Between 8th and 9th dorsal vertebrae.
	9 T or D	A. Midway between spines of 5th and 6th thoracic vertebrae. B. Upper border spine of 7th thoracic vertebra.	IX D	Between 9th and 10th dorsal vertebrae.
	10 T or D	A. Midway between spines of 6th and 7th thoracic vertebrae. B. Middle of spine of 8th thoracic vertebra.	X D	Between 10th and 11th dorsal vertebrae.
	11 T or D	A. Junction of upper $\frac{1}{4}$ and lower $\frac{3}{4}$ of spine of 7th thoracic vertebra. B. Just above spine of 9th thoracic vertebra.	XI D	Between 11th and 12th dorsal vertebrae.

	Nerve	Root or Origin	Nerve	Exit of Nerve
	12 T or D	A. Junction of upper $\frac{1}{4}$ and lower $\frac{3}{4}$ of spine of 8th thoracic vertebra B. Just below spine of 9th thoracic vertebra.	XII D	Between 12th dorsal and 1st lumbar vertebrae.
LUMBAR SEGMENT	1 L	A. Midway between spines of 8th and 9th thoracic vertebrae. B. Lower border of spine of 10th thoracic vertebra.	I L	Between 1st and 2d lumbar vertebrae.
	2 L	A. Middle of spine of 9th thoracic vertebra. B. Junction of upper $\frac{1}{3}$ and lower $\frac{2}{3}$ of spine of 11th thoracic vertebra.	II L	Between 2d and 3d lumbar vertebrae.
	3 L	A. Middle of spine of 10th thoracic vertebra. B. Just below spine of 11th thoracic vertebra.	III L	Between 3d and 4th lumbar vertebrae.
	4 L	A. Just below spine of 10th thoracic vertebra. B. Junction of upper $\frac{1}{4}$ and lower $\frac{3}{4}$ of spine of 12th thoracic vertebra.	IV L	Between 4th and 5th lumbar vertebrae.
	5 L	A. Junction of upper $\frac{1}{3}$ and lower $\frac{2}{3}$ of spine of 11th thoracic vertebra. B. Middle of spine of 12th thoracic vertebra.	V L	Between 5th lumbar vertebra and base of sacrum.
SACRAL SEGMENT	1 S	A. Just above lower border of spine of 11th thoracic vertebra.	I S	Ant. division— I Ant. sacral foramina. Post. division— I Post. sacral foramina.
			II S	Ant. division— II Ant. sacral foramina. Post. division— II Post. sacral foramina.
			III S	Ant. division—III Ant. sacral foramina. Post. division—III Post. sacral foramina.
			IV S	Ant. division —IV Ant. sacral foramina. Post. division— IV Post. sacral foramina.
	5 S	B. Lower border of spine of 1st lumbar vertebra.	V S	Foramen between sacrum and coccyx.
	Coccygeal	A. Lower border of spine of 1st lumbar vertebra. B. Just below upper border of spine of 2d lumbar vertebra.	1 Coccygeal	Ant. branch at end of sacral canal.

ACTION OF GROUPS OF MUSCLES, THEIR ORIGIN, INSERTION, AND NERVE SUPPLY.*

MUSCLE. *Head moved forward by*	ORIGIN.	HEAD. INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Platysma myoides	Clavicle, acromion and fascia covering upper part of pectoral, deltoid and trapezius muscles.	Inf. maxil., angle of mouth, cellular tissue of face.	Facial and superficial branches of the cervical plexus from 2d and 3d c. nerves.	Ant. cervical triangle level with larynx (m. p. for facial).*
Sterno-cleido-mastoid.	Two heads, sternum and clavicle.	Mastoid process of temporal bone, and outer 2-3 of sup. curved line of occiput.	Sp. accessory, and deep branches of cervical plexus.	Medulla and 2 and 3 cer. segments.
Rectus capitis anticus major.	Transverse processes of 3d to 6th cervical inclusive.	Basilar process of occiput. .	Sub. occipital (1st cervical nerve) and deep internal branches of cervical plexus	Upper c. segments.
Rectus capitis anticus minor.	Root of trans. process and lateral mass of atlas.	Basilar process of occipital bone.	Sub. occipital (1st cervical nerve) and deep internal branches of cervical plexus.	Upper c. segments.
When the lower jaw is fixed the movement of the head forward is assisted by				
Mylo-hyoid. , ...	Mylo-hyoid ridge of inferior maxillary.	Body of hyoid and raphé. . .	Inf. dental (5th cranial).	
Genio-hyoid.	Inf. genial tubercle on inner side of symphysis of jaw.	Ant. surface of body of hyoid	Hypo-glossal.	
Genio-hyo-glossus	Superior genial tubercle on inner side of symphysis of jaw.	Body of hyoid bone a few fibres being continued to side of pharynx, under surface of tongue.	Hypo-glossal (12th cranial).	
Digastric — Anterior Belly ..	Inner surface inferior maxillary near symphysis.	A central tendon held in connection with hyoid bone by a fibrous loop.	(Ant.) Inf. Dental (5th cranial).	
Digastric — Posterior Belly ..	Digastric groove of mastoid process.	Supra-hyoid aponeurosis is attached to body and great cornu of hyoid bone.	(Post.) Facial.	
Head moved backward by				
Part of trapezius.........	Superior curved line of occiput, spinous processes of 7th cervical and all dorsal, lig. nuchæ, and supraspinous ligament.	Clavicle, and crest of spine of scap., and acromion and tubercle of scapula.	Spinal accessory and branches from anterior divisions of 3d and 4th cervical nerves.	Medulla, and 2, 3 and 4 c. or 1, 2, 3 and 4 c. segments.

* Findings are based on Dunglison's Medical Dictionary, Gray's Anatomy, Belousow-Krauses' work, Thorburn's findings, Gould's Medical Dictionary Skarstrom's Gymnastic Kinesiology, Despard's Text-book of Massage, Spondylotherapy, and Starr's and Butler's works.

Splenius capitis	Half of lig. nuchæ, and spines of 6 upper dorsal and last cervical vertebræ and supraspinous ligament.	(Splen. cap.) Into occiput and mastoid process of temporal bone. (Splen. colli (Into trans. process. of 3 or 4 upper cervical vertebræ.	Ext. branches of post. divisions of cervical nerves (2d and 3d c. nerves).	1, 2 and 3 c. segments.
Complexus.	Transverse process of 7th cervical and 3 upper dorsal, and articular process of 4th, 5th and 6th cervical.	Occipital bone	Sub.-occip. (from 1st c. nerve), great occip. (from 2d c. nerve), and branches of post. divisions of cervical nerves (3d, 6th, 7th and 8th c. nerves)	
Trachelo-mastoid	Transverse process of 3d, 4th, 5th and 6th dorsal and articular process of 3 or 4 lower cervical.	Mastoid process	Ext. branches of post. divisions of cervical nerves (2d, 3d, 4th, 5th, 6th, 7th and 8th).	
Rectus capitis posticus major	Spine of axis.............	Inf. curved line of occiput and surface of bone below it.	Sub-occipital (1st cervical nerve,—post. division)	
Rectus capitis posticus minor	Post. arch of atlas........	Rough surface beneath inf. curved line of occip. bone nearly as far as foramen magnum.	Sub-occipital (1st cervical nerve).	
Obliquus capitis superior...	Transverse process atlas....	Occipital bone between the two curved lines external to the Complexus.	Sub-occipital (1st cervical nerve).	
Head moved laterally by Rectus capitis lateralis.....	Trans. process of atlas....	Jugular process of occipital bone.	Sub-occipital (from 1st c. nerve), and cervical plexus. (1st c. and loop between 1st and 2d c. nerves).	Upper c. segments.
Also by Sterno mastoid, splenius capitis, trachelo-mastoid, complexus and obliquus capitis superior				
Head moved to either side by				
Platysma myoides	Clavicle, acromion, and fascia covering upper part of pectoral, deltoid, and trapezius muscles.	Inf. maxillary, angle of mouth, cellular tissue of face.	Facial and superficial branches of the cervical plexus (2d and 3d cervical nerves).	Ant. cervical triangle level with larynx (m. p. for facial).

* m. p. for motor point, c. for cervical, d. for dorsal, l. for lumbar, s. for sacral.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Sterno-cleido-mastoid	Two heads, sternum and clavicle.	Mastoid proc. of temporal bone, and outer 2-3 of sup. curved line of occiput.	Sp. accessory and deep branches of cervical plexus.	Medulla, and 2 and 3 c. segments.
Part of trapezius..........	Sup. curved line of occipital, spinous processes of 7th cerv. and all dorsal, lig. nuchæ, and supraspinous ligament.	Clavicle, and crest of spine of scapula and acromion, and tubercle of scapula.	Sp. accessory and branches from anterior divisions of 3d and 4th cervical nerves.	Medulla, 2, 3 and 4 c. or 1, 2, 3 and 4 c. segments.
Splenius capitis et colli.....	Half of lig. nuchæ, and spines of six upper dorsal and last cervical vert. and supraspinous ligament.	(Splen. cap.) Into occiput and mastoid process of temporal bone. (Splen. colli.) Into trans. proc. of 3 or 4 upper cervical vertebræ.	Ext. branches of post. divisions of cervical nerves (2d and 3d c. nerves).	1, 2 and 3 c. segments (splen. cap).
Trachelo-mastoid	Trans. proc. of 3d, 4th, 5th and 6th dorsal and artic. proc. of 3 or 4 lower cervical.	Mastoid process of temporal bone.	Ext. branches of post. divisions of cervical nerves (2d, 3d, 4th, 5th, 6th, 7th and 8th).	
Complexus .... and Obliquus capitis inf. Obliquus capitis sup.	Trans. proc. 7th cervical and 3 upper dorsal, and artic. proc. of 3d, 4th, 5th and 6th cervical.	Occipital bone	Sub-occipital (1st c. nerve), great occipital (from 2d c. nerve), and branches of post. divisions of cervical nerves (3d, 6th, 7th and 8th c. nerves).	
Rectus capitis posticus major	Spine of axis.............	Inf. curved line of occiput and surface of bone below it.	Sub-occipital (1st cervical nerve,—post division).	
Rectus capitis posticus minor	Post arch of atlas.........	Rough surface beneath inf. curved line of occip. bone nearly as far as foramen magnum.	Sub-occipital (1st cervical nerve).	
		NECK.		
Neck moved forward by				
Platysma myoides	Clavicle, acromion, and fascia covering upper part of pectoral, deltoid, and trapezius muscles.	Inf. maxil., angle of mouth, cellular tissue of face.	Facial and superficial branches of the cervical plexus (2d and 3d cervical nerves).	Ant. cervical triangle level with larynx (m. p. for facial).

Sterno-cleido-mastoid	Two heads, sternum and clavicle.	Mastoid proc. of temporal bone, and outer 2-3 of superior curved line of occiput.	Sp. accessory and deep branches of cervical plexus.	Medulla, 2 and 3 c. segments.
Digastric { Anterior belly ..	Inner surface inf. maxillary near symphysis.	A central tendon held in connection with hyoid bone by a fibrous loop. Suprahyoid aponeurosis is attached to body and great cornu of hyoid bone.	(Ant.) Inferior dental (5th cranial).	
Digastric { Posterior belly ..	Digastric groove of mastoid process.		(Post.) Facial.	
Mylo-hyoid.	Mylo-hyoid ridge of inferior maxillary.	Body of hyoid and raphé. . .	Inferior dental (5th cranial).	
Genio-hyoid	Inf. genial tubercle on inner side of symphysis of jaw.	Ant. surface of body of hyoid.	Hypo-glossal.	
Genio-hyo-glossus	Superior genial tubercle on inner side of symphysis of jaw.	Body of hyoid bone, a few fibres being continued to side of pharynx, under surface of tongue.	Hypo-glossal (12th cranial).	
Omo-hyoid	Upper border of scapula and occasionally from transverse ligament.	Body of hyoid.	Branches from loop of communication bet. descendens and communicans hypoglossi (2d and 3d c. nerves).	1, 2, 3 c. segments.
Sterno-hyoid	Sternum and clavicle.	Lower border of body of hyoid bone.	Branches from loop of communication bet. descendens and communicans hypoglossi (2d and 3d c. nerves).	1, 2, 3 c. segments.
Thyro-hyoid.	Side of thyroid cartilage. . . .	Body and greater cornu of hyoid.	Hypo-glossal.	
Rectus capitis anticus minor.	Root of trans. proc. and lateral mass of atlas.	Basilar process of occipital bone.	Sub-occipital (1st cervical nerve), and deep inter. branches of cervical plexus.	Upper c. segments.
Longus colli { Sup. oblique portion	Trans. proc. 3d, 4th, 5th cervical.	Tubercle on anter. arch of atlas.		
Longus colli { Inf. oblique portion	Trans. proc. first 2 or 3 dorsal vert.	Trans. proc. 5th, 6th cervical.	Anterior branches of lower cervical nerves.	Lower c. segments.
Longus colli { Vertical portion	Bodies of lower 3 cervical, and upper 3 dorsal.	Bodies of 2d, 3d, 4th cervical.		
Neck moved backward by				
Part of trapezius.	Sup. curved line of occipital, spinous proc. of 7th cervical and all dorsal, lig. nuchæ, and supraspinous lig.	Clavicle and crest of spine of scap. and acromion, and a tubercle of scapula.	Spinal accessory and branches from anterior divisions of 3d and 4th cervical nerves.	Medulla, 2, 3, and 4 c. or 1, 2, 3, and 4 c. segments.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Rhomboideus minor	Lig. nuchæ, spines of 7th cervical and 1st dorsal.	At root of spine of scapula..	Branches from 5th cervical nerve.	4 and 5 c. segments.
Serratus posticus superior..	Lig. nuchæ, spines of last cervical and 2 or 3 upper dorsal vertebræ.	2d, 3d, 4th and 5th ribs by four digitations.	External branches of posterior divisions of cervical nerves.	
Splenius capitis et colli.....	Half of lig. nuchæ and spines of 6 upper dorsal and last cervical vert. and supraspinous ligament.	(Splen. cap.) Into occiput and mastoid process of temporal bone. (Splen. colli.) Trans. proc. 3 or 4 upper cervical vertebræ.	External branches of posterior divisions of cervical nerves.	1, 2 and 3 c. segments.
Complexus.	Trans. proc. 7th cervical and 3 upper dorsal and artic. proc. of 4th, 5th and 6th cervical.	Occipital bone	Sub-occip. (from 1st c. nerve), great occipital (from 2d c. nerve), and branches of post. divisions of cervical nerves (from 3d, 6th, 7th, and 8th c. nerves.)	
Trachelo-mastoid	Trans. proc. 3d, 4th, 5th and 6th dorsal and art. proc. of 3 or 4 lower cervical.	Mastoid process	External branches of posterior divisions of cervical nerves (2d, 3d, 4th, 5th, 6th, 7th and 8th.)	
Transversalis colli	Transverse process, 6 upper dorsal vertebræ.	Posterior tubercles of trans. processes of 2d to 6th cervical.	External branches of posterior divisions of the cervical nerves (4tn, 5th, 6th, 7th and 8th).	
Interspinales colli	Bet. spines of contiguous vert. The interspinales in cervical region consist of six pairs, the 1st bet. axis and third vertebræ, the last bet. last cervical and first dorsal.	....	Internal branches of posterior divisions of cervical nerves (6th, 7th and 8th).	
Semispinales colli	Trans. proc. upper 4 dorsal, and artic. proc. of lower 4 cervical.	Spines of cervical from axis to 5th cervical vertebræ.	Internal branches of posterior divisions of cervical nerves (6th, 7th and 8th).	
Rectus capitis posticus major	Spine of axis.............	Inf. curved line of occiput and surface of bone below it.	Sub-occipital (1st cervical nerve, post. division).	

Rectus capitis posticus minor.	Post. arch of atlas........	Rough surface beneath the inf. curved line of occip. bone nearly as far as foramen magnum.	Sub-occipital (1st cervical nerve, post. division).	
Obliquus capitis superior...	Transverse process of atlas..	Occipital bone bet. the two curved lines external to the complexus.	Sub-occipital (1st cervical nerve, post. division).	
Obliquus capitis inferior ...	Spinous process of axis....	Trans. process of atlas....	Sub. and great occipital (post. div. of 1st and 2d cervical nerves).	
Scaleni postici	2d rib	Trans. processes of lower 2 or 3 cervical vertebræ.	Anterior branches of lower cervical.	Lower c. segments.
Levator anguli scapulæ.....	Trans. processes of 3, 4, or 5 upper cervical.	Posterior border of scapula..	Anterior division of 3d and 4th cervical nerves.	2 and 4(?) or 3-5 c. segment.
Neck moved laterally by				
Various combinations of those muscles which separately move it forward and backward, assisted by the scaleni, inter-transversales and recti laterales.				
		TRUNK.		
Trunk moved forward by				
Rectus abdominis	Pubic crest, small portion interlaces with its opposite being connected with ligaments covering the symphysis.	Cartilages of 5th, 6th and 7th ribs. Occasionally some fibres connected with costoxiphoid ligaments and side of ensiform cartilage.	Lower intercostals (lower 6 dorsal nerves), ilio-hypogastric (1st lumbar nerve) and ilio-inguinal (1st lumbar nerve).	5-12 d. segment.
Pyramidalis	Os pubis and ant. pubic ligament.	Linea alba	Lower intercostals (lower 6 dorsal nerves), ilio-hypogastric (1st lumbar nerve) and ilio-inguinal (1st lumbar nerve).	
Obliquus externus abdominis	Eight lower ribs..........	Outer lip of crest of ilium. Aponeurosis interlaces with its opposite, forming linea alba; above it is connected with pectoralis major, below from ant. sup. spine of ilium to pubic spine and linea-ilio-pectinea.	Lower intercostals (lower 6 dorsal nerves, ilio-hypogastric (1st lumbar nerve), ilio-inguinal nerves (1st lumbar nerve).	5-12 d. or 1 l. segment.
Obliquus internus	Lumbar fascia, iliac crest, Poupart's ligament.	Cartilages 4 lower ribs, linea alba, pubic crest, pectineal line.	Lower intercostal, ilio-hypogastric, ilio-inguinal nerves.	7 d.–1 l. or 1 l. segment.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Psoas magnus	Bodies and trans. proc., and intervertebral substances of last dorsal and all lumbar vertebræ.	Lesser trochanter of femur.	Ant. branches of lumbar nerves.	1 and 2 l. segments.
Psoas parvus	Bodies of last dorsal and first lumbar vertebra and the intervertebral sub.	Ilio-pectineal eminence, and continuous with iliac fascia.	Ant. branches of lumbar nerves.	
Assisted when arms are carried forward by				
Pectoralis major	Clavicle, sternum, and costal cartilages of all the true ribs except frequently 1st or 7th or both, and aponeurosis of obliquus externus abdom.	Ant. bicipital ridge of humerus.	Anterior thoracic nerves (5th, 6th, 7th, 8th c. and 1st d. nerves).	5, 6, 7 and 8 c. segments or 6 c. nerve.
Pectoralis minor	3d, 4th and 5th ribs, and intercostal aponeurosis.	Coracoid process of scapula.	Anterior thoracic nerves (8th c. and 1st d. nerves).	7 c. segment.
Serratus magnus	8 upper ribs and intercostal aponeurosis.	Anterior aspect of posterior border of scapula.	Posterior thoracic nerves (5th and 6th c. nerves, usually 7th also).	5 and 6 c. segments or 6 c. nerve.
Trunk moved backward by				
Trapezius	Sup. curved line of occiput, spinous proc. of 7th cervical and all dorsal vertebræ, lig. nuchæ, and supraspinous ligament.	Clavicle, and crest of spine of scapula, acromion, and a tubercle of scapula.	Spinal accessory and deep branches from anterior divisions of 3d and 4th cervical nerves.	Medulla, and 2, 3 and 4 c. or 1, 2, 3 and 4 c. segments.
Rhomboideus major	Spines of 4 or 5 upper dorsal vertebrae and supraspinous ligament.	Into an arch attached to triangular surface near the spine and inf. angle. Occasionally into the scapula.	Fifth cervical.	4 and 5 c. segments.
Latissimus dorsi	Spines of 6 lower dorsal and lumbar and sacral vertebræ, supraspinous lig., crest of ilium and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long subscapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.
Serratus posticus superior	Lig. nuchæ, spines of last cervical and 2 or 3 upper dorsal vertebræ.	2d, 3d, 4th and 5th ribs by 4 digitations.	External branches of posterior divisions of cervical nerves.	

Serratus posticus inferior...	Spines of last two dorsal and first 2 or 3 upper lumbar vertebræ and interspinous ligaments.	Four lower ribs..........	External branches of posterior divisions of lower dorsal nerves.	
Sacrolumbalis.	Is a part of erector spinæ..	Angles of 6 or 7 lower ribs..	External branches of posterior divisions of lumbar and dorsal nerves.	1 d.–5 l. segment.
Longissimus dorsi	Is inner part of erector spinæ.	Trans. and artic. proc. of lumbar and trans. processes of all dorsal vertebræ and from 7th to 11th lower ribs, and aponeurosis of transversalis abdominis.	External branches of post. divisions of lumbar and dorsal nerves.	
Spinalis dorsi	Last 2 dorsal and first 2 lumbar spines.	Spinous processes of dorsal vertebræ from 4 to 8 in number.	Dorsal branches.	
Semispinales dorsi	Trans. proc. lower dorsal from 10th or 11th to 5th or 6th.	Spines last 2 cervical and upper 4 dorsal vertebræ.	Internal branches of posterior divisions of 6 upper dorsal nerves.	
Multifidus spinæ	Sacrum and an aponeurosis of origin of erector spinæ, iliac spine, post. sacro-iliac lig., artic, proc. lum. and cer. ver. and trans. proc. of dorsal.	Laminæ and spines of vertebræ next above.	Internal branches of posterior divisions of cervical, dorsal, lumbar and sacral nerves.	
Intertransversales dorsi et lumborum.	Bet. transverse processes of contiguous vertebræ.	....	Branches of post. division of cervical, dorsal, and lumbar nerves.	
Trunk moved laterally by Obliquus externus	8 lower ribs..............	Outer lip of crest of ilium. Aponeurosis interlaces with its opposite, forming linea alba. Above it is connected with pectoralis major, below from ant. sup. spine of ilium to pubic spine and linea-ilio-pectinea.	Lower intercostals (lower 6 dorsal nerves), ilio-hypogastric (1st lumbar nerve), ilio-inguinal (1st lumbar nerve).	5-12 d. or 1 l. segment.
Obliquus internus	Lumbar fascia, iliac crest, Poupart's ligament.	Cartilages of four lower ribs, linea alba, pubic crest, pectineal line.	Lower intercostals (lower 6 dorsal nerves), ilio-hypogastric (1st lumbar nerve), and ilio-inguinal (1st lumbar nerve).	7 d.–1 l. or 1 l. segment.
Quadratus lumborum	Ilio-lum. lig., crest of ilium., trans. proc. 3d, 4th, and 5th lumbar vertebræ.	Last rib, trans. proc. of the 4 upper lumbar vertebræ, lower margin of last rib.	Anterior branches of lumbar nerves.	1 l. segment.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Longissimus dorsi	Is inner part of erector spinæ.	Trans. and artic. proc. of lumbar and trans. proc. of all dorsal vertebræ, and from 7th to 11th ribs, and aponeurosis of trans. abdominls.	External branches of posterior divisions of lumbar and dorsal nerves.	1 d.–5 l. segment.
Sacrolumbalis	Is a part of erector spinæ.	Angles of 6 or 7 lower ribs.	External branches of posterior divisions of lumbar and dorsal nerves.	1 d.–5 l. segment.
Serratus postici — Superior	Lig. nuchæ, spines of last cervical and 2 or 3 upper dorsal vertebræ.	2d, 3d, 4th and 5th ribs by 4 digitations.	External branches of posterior divisions of cervical nerves.	
Serratus postici — Inferior	Spines of last 2 dorsal and first 2 or 3 upper lumbar vertebræ and interspinous ligament.	Four lower ribs	External branches of posterior divisions of lower dorsal nerves.	
Latissimus dorsi	Spines of 6 lower dorsal and lumbar and sacral vertebræ, supraspinous lig., crest of ilium, and 3 or 4 lower ribs.	Into lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long subscapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.
Scapula moved upward by		SCAPULA.		
Trapezius (upper)	Sup. curved line of occiput, spinous proc. of 7th cervical and all dorsal, lig. nuchæ and supraspinous ligament.	Clavicle and crest of spine of scapula and acromion and a tubercle of scapula.	Spinal accessory and deep branches from anterior divisions of 3d and 4th cervical nerves.	Medulla, and 2, 3 and 4 c. or 1, 2, 3 and 4 c. segments.
Levator anguli scapulae	Trans. proc. 3, 4 or 5 upper cervical vertebræ.	Post. border of scapula	Anterior divisions of 3d and 4th cervical nerves.	2 and 4(?) c. or 3–5 c. segments.
Rhomboidei — Major	Spines of 4 or 5 upper dorsal and supraspinous lig.	Into arch attached to triangular surface near the spine, and inf. angle. Occasionally into the scapula.	5th cervical	4 and 5 c. segments.
Rhomboidei — Minor	Lig nuchæ, spines of 7th cer. and 1st dorsal.	At root of spine of scapula.	Branches from 5th cervical nerve.	

Scapula moved downward by				
Lower part of trapezius....	Sup. curved line of occiput, spinous processes of 7th cervical and all dorsal vertebræ, lig. nuchæ, and supraspinous ligament.	Clavicle and crest of spine of scapula and acromion and a tubercle of scapula.	Spinal accessory and branches from anterior divisions of 3d and 4th cervical nerves.	Medulla, and 2, 3 and 4 c. or 1, 2, 3, and 4 c. segments.
Serratus magnus (lower part)	8 upper ribs and intercostal aponeurosis.	Ant. aspect of post. border of scapula.	Post. thoracic nerve (5th and 6th cervical nerves, usually 7th also).	5 and 6 c. segments or 6 c. nerve.
Pectoralis minor	3d, 4th and 5th ribs and intercostal aponeurosis.	Coracoid process of scap...	Ant. thoracic nerve (8th cervical and 1st dorsal).	7 c. segment.
and indirectly by				
Latissimus dorsi	Spines of 6 lower dorsal and lumbar and sacral vertebræ, supraspinous lig., crest of ilium and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long subscapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.
Subclavius	Cartilage of 1st rib........	Under surface of clavicle...	Branch from 5th and 6th cervical nerves.	
Pectoralis major (lower part)	Clavicle, sternum, and costal cartilages of all the true ribs except frequently the 1st or 7th or both and aponeurosis of obliquus externus abdominis.	Ant. bicip. ridge of humerus.	Ant. thoracic nerves (5th, 6th, 7th and 8th cervical and 1st dorsal nerves).	5, 6, 7 and 8 c. segments or 6 c. nerve.
Scapula abducted by				
Pectoralis minor	3d, 4th and 5th ribs and intercostal aponeurosis.	Coracoid process of scap...	Ant. thoracic nerve (8th cervical and 1st dorsal).	7 c. segment.
Serratus magnus	8 upper ribs and intercostal aponeurosis.	Ant. aspect of post. border of scapula.	Post. thoracic nerve (5th and 6th cervical nerves, usually 7th also).	5 and 6 c. segments or 6 c. nerve.
and indirectly by				
Pectoralis major	Clavicle, sternum and costal cartilages of all the true ribs except frequently the 1st or 7th or both and aponeurosis of obliquus externus abdominis.	Ant. bicip. ridge of humerus.	Ant. thoracic nerves (5th, 6th, 7th and 8th cervical, and 1st dorsal nerves).	5, 6, 7 and 8 c. segments or 6 c. nerve.
Scapula adducted by				
Trapezius	Sup. curved line of occip., spinous proc. 7th cervical and all dorsal vertebræ, lig. nuchæ, and supraspin. ligament.	Clavicle and crest of spine of scapula, acromion and a tubercle of scapula.	Spinal accessory and deep branches from anterior divisions of 3d or 4th cervical nerves.	Medulla, and 2, 3 and 4 c. or 1, 2, 3 and 4 c. segments.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Rhomboidei: Major	Spines of 4 or 5 upper dorsal, and supraspinous lig.	Into arch attached to triangular surface near the spine, and inf. angle. Occasionally into the scapula.	5th cervical	4 and 5 c. segments.
Rhomboidei: Minor	Lig. nuchæ, spines of 7th cer. and 1st dorsal.	At root of spine of scapula..	Branches from 5th cervical	
Levator anguli scapulæ.....	Trans. proc. 3, 4 or 5 upper cervical vertebræ.	Post. border of scapula....	Anterior divisions of 3d and 4th cervical nerves.	2 and 4(?) c. or 3–5 c. segment.
and indirectly by Latissimus dorsi	Spines of 6 lower dor. and lum. and sacral ver., supraspinous lig., crest of ilium and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long subscapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.
Rotators upward				
Trapezius	Sup. curved line of occiput, spinous proc. of 7th cervical and all dorsal vertebræ, lig. nuchæ, and supraspinous ligament.	Clavicle and crest of spine of scapula, acromion and a tubercle of scapula.	Spinal accessory and deep branches from anterior divisions of 3d or 4th cervical nerves.	Medulla, and 2, 3 and 4 c. or 1, 2, 3 and 4 c. segments.
Serratus magnus	8 upper ribs and intercostal aponeurosis.	Ant. aspect of post. border of scapula.	Post. thoracic nerve (5th and 6th cervical nerves, usually 7th also).	5 and 6 c. segments or 6 c. nerve.
Rotators downward				
Rhomboidei: Major	Spines of 4 or 5 upper dorsal, and supraspinous lig.	Into arch attached to triangular surface near the spine, and inf. angle. Occasionally into the scapula.	5th cervical	4 and 5 c. segments.
Rhomboidei: Minor	Lig. nuchæ, spines of 7th cer. and 1st dorsal.	At root of spine of scapula..	Branches from 5th cervical nerve.	
Levator anguli scapulæ....	Trans. proc. 3, 4 or 5 upper cervical vertebræ.	Post. border of scapula....	Anterior divisions of 3d and 4th cervical nerves.	2 and 4(?) c. or 3–5 c. segments.
Pectoralis minor	3d, 4th, 5th ribs and intercostal aponeurosis.	Coracoid process of scap...	Ant. thoracic nerve........	7 c. segment.
and indirectly by Latissimus dorsi	Spines of 6 lower dorsal, and lumbar and sacral vertebræ, supraspinous lig., crest of ilium, and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long subscapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.

Pectoralis major (lower part).	Clavicle, sternum, and costal cartilages of all the true ribs except frequently the 1st or 7th or both, and aponeurosis of obliquus externus abdominis.	Ant. bicip. ridge of humerus.	Anterior thoracic nerves (5th 6th, 7th, 8th cervical and 1st dorsal nerves.	5, 6, 7 and 8 c. segments or 6 c. nerve.
Humerus moved forward by				
Part of deltoid............	Clavicle, acromion, and spine of scapula.	Middle of outer side of shaft of humerus.	Circumflex (5th, 6th and 7th cervical nerves).	5, 6 and 7 c. segments or 5 c. nerve.
Part of pectoralis major....	Clavicle, sternum, and costal cartilages of all the true ribs except frequently the 1st or 7th or both, and aponeurosis of obliquus externus abdominis.	Ant. bicip. ridge of humerus.	Anterior thoracic nerves (5th, 6th, 7th, 8th c. and 1st d. nerves).	5, 6, 7 and 8 c. segments or 6 c. nerve.
Assisted in some circumstances by				
Biceps	1. Long head—Glenoid cavity. 2. Short head—Coracoid process.	Tuberosity of radius.......	Musculo-cutaneous (5th, 6th and 7th c. nerves).	5 and 6 c. segments or 5 c. nerve.
Coracobrachialis	Coracoid process of scap. and intermuscular septum.	Inside shaft of humerus....	Musculo-cutaneous (5th, 6th and 7th c. nerves).	6 c. segment.
Humerus moved backward by				
Part of deltoid...........	Clavicle, acromion, and spine of scapula.	Middle of outer side of shaft of humerus.	Circumflex (5th, 6th and 7th c. nerves).	5, 6 and 7 c. segments or 5 c. nerve.
Teres major	Inf. angle scap. and fibrous septa bet. the teres major and teres minor and infraspinatus.	Post. bicipital ridge of humerus.	Lower sub-scapular (5th, 6th and 7th c. nerves).	6 and 7 c. segments or 6 c. nerve.
Teres minor	Axillary border of scapula, and 2 aponeurotic laminæ.	Great tuberosity of humerus and bone below.	Circumflex (5th, 6th and 7th c. nerves).	5 and 6 c. segments or 4 c. (?) nerve.
Long head of triceps......	From a depression below the glenoid cavity.	Olecranon process of ulna..	Musculo-spiral (5th, 6th, 7th, 8th c. and 1st d. nerves).	6, 7 and 8 c. segments or 6 c. nerve.
Latissimus dorsi	Spines of 6 lower dor., and lum. and sac. ver., supraspinous lig., crest of ilium, and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long sub-scapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.
Humerus moved inward by				
Part of pectoralis major....	Clavicle, sternum, and costal cartilages of all the true ribs except frequently 1st or 7th or both, and aponeurosis of obliquus externus abdominis.	Ant. bicipital ridge of humerus.	Anterior thoracic nerves 5th, 6th, 7th, 8th c. and 1st d. nerves).	5, 6, 7 and 8 c. segments or 6 c. nerve.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Latissimus dorsi	Spines of 6 lower dorsal and lum. and sacral ver., suprasin. lig., crest of ilium and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long sub-scapular (5th, 6th and 7th cervical nerves).	6 and 7 c. segments or 6 c. nerve.
Humerus rotated inward by				
Subscapularis	Subscapular fossa and tendinous laminæ and an aponeurosis.	Lesser tuberosity of humerus and neck of humerus.	Upper and lower sub-scapular nerves (5th, 6th and 7th c. nerves).	5, 6 and 7 c. segments or 6 c. nerve.
Pectoralis major	Clavicle, sternum, and costal cartilages of all the true ribs except frequently the 1st or 7th or both, and aponeurosis of obliquus externus abdominis.	Ant. bicipital ridge of humerus.	Anterior thoracic nerves (5th, 6th, 7th, 8th c. and 1st d. nerves).	5, 6, 7 and 8 c. segments or 6 c. nerve.
Latissimus dorsi	Spines of 6 lower dorsal and lumbar and sacral ver., supraspinous lig., crest of ilium and 3 or 4 lower ribs.	Inner lip and bicipital groove of humerus. Lower border of tendon unites with teres major.	Long sub-scapular (5th, 6th and 7th c. nerves).	6 and 7 c. segments or 6 c. nerve.
Teres major	Inf. angle of scapula and fibrous septa between the teres major and teres minor and infra-spinatus.	Posterior bicipital ridge of humerus.	Lower sub-scapular (5th, 6th and 7th c. nerves).	6 and 7 c. segments or 6 c. nerve.
Deltoid (ant. fibres).......	Clavicle, acromion and spine of scapula.	Middle of outer shaft of humerus.	Circumflex (5th, 6th and 7th c. nerves).	5, 6 and 7 c. segments or 5 c. nerve.
Humerus rotated outward by				
Supraspinatus(?)	Supra-spinous fossa and fascia covering the muscle.	Great tuberosity of humerus.	Supra-scapular (5th and 6th cervical nerves).	4 and 5 c. segments or 4 c. nerve.
Infraspinatus	Infra-spinous fossa and covering fascia.	Great tuberosity of humerus.	Supra-scapular (5th and 6th cervical nerves).	5 and 6 c. segments.
Teres minor	Axillary border of scap. and 2 aponeurotic laminæ.	Great tuberosity of humerus and bone below.	Circumflex (5th, 6th and 7th cervical nerves).	5 and 6 c. segments or 4 c. (?) nerve.
Deltoid Apost. fibres)......	Clavicle, acromion and spine of scapula.	Middle of outer shaft of humerus.	Circumflex (5th, 6th and 7th c. nerves).	5, 6 and 7 c. segments or 5 c. nerve.
		FOREARM.		
Forearm moved forward by				
Biceps	1. Long—Glenoid cavity. 2. Short—Coracoid process.	Tuberosity of radius.......	Musculo-cutaneous (5th, 6th and 7th cervical nerves).	5 and 6 c. segments or 5 c. nerve.

Brachialis anticus	Lower half of outer and inner surfaces of shaft of humerus and intermuscular septum.	Coronoid process of ulna...	Musculo-cutaneous and musculo-spiral (5th, 6th, 7th and 8th c. and 1 d. nerves).	6 and 7 c. segments or 5 c. nerve.
Pronator radii teres.......	Humerus above internal condyle and common tendon and fascia of forearm and intermuscular septum and coronoid process.	Outer side of shaft of radius.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	6 c. segment.
Assisted by **Flexor carpi radialis**.......	Internal condyle and from fascia of forearm and intermuscular septum.	Base of metacarpal bone of index.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Flexor digitorum sublimis...	1. Internal condyle and int. lat. lig. of elbow-jt. and intermus. septum. 2. Coronoid process ..... 3. Oblique line of radius.	2d phalanges by 4 tendons..	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Flexor carpi ulnaris.......	1. Int. condyle .... 2. Olecranon by an aponeurosis from ulna, and intermus. septum.	Base of 5th metacarpal, unciform bone, annular lig., and pisiform bone.	Ulnar (8th c. and 1st d. nerves).	8 c. segment.
Supinator longus	Ext. condyloid ridge of humerus and ext. intermus-termus. septum.	Styloid process of radius...	Musculo-spiral (5th, 6th, 7th, 8th c. and 1 d. nerves).	5–7 c. segments or 5 c. nerve.
Forearm moved backward by				
Triceps	1. Ext. head—post. surface of shaft of humerus, external border of humerus and ext. intermuscular septum. 2. Internal head from post. surface of shaft of humerus, internal border of humerus and intermuscular septum. 3. Middle or long from a depression below the glenoid cavity.	Olecranon process of ulna...	Musculo-spiral (5th, 6th, 7th, 8th c. and 1 d. nerves).	6, 7 and 8 c. segments or 6 c. nerve.
Anconeus	Back of ext. condyle of humerus.	Olecranon and shaft of ulna.	Musculo-spiral (5th, 6th, 7th, 8th c. and 1 d. nerves).	
Forearm rotated inward by **Pronator radii teres**........	Humerus above internal condyle and common tendon and fascia of forearm and intermus. septum and coronoid process.	Outer side shaft of radius..	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	6 c. segment.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Flexor carpi radialis.......	Int. condyle and from fascia of forearm and intermus. septum.	Base of metacarpal bone of index.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Palmaris longus	Int. condyle, deep fascia and intermuscular septum.	Palmar fascia. Frequently sends a tendinous slip to short muscles of thumb.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Flexor digitorum sublimis..	1. Int. condyle and int. lat. lig. of elbow-jt. and intermuscular septum. 2. Coronoid process. 3. Oblique line of radius.	2d phalanges by 4 tendons..	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Pronator quadratus	Lower ¼ of ant. surface of shaft of ulna and surface of bone below it; anterior border of ulna and an aponeurosis which covers inner ⅓ of muscle.	Lower ¼ of ant. surface and ext. border of shaft of radius.	Ant. interosseus (Median).	8 c. segment.
Forearm rotated outward by				
Biceps	1. Long—Glenoid cavity ... 2. Short—Coronoid process .	Tuberosity of radius.......	Musculo-cutaneous (5th, 6th and 7th c. nerves).	5 and 6 c. segments or 5 c. nerve.
Supinator brevis	Ext. condyle of humerus, ext. lat. lig. of elbow-jt. and orbicular lig. of radius, the ridge on ulna from triangular depression in front of it and tendinous expansion covering the muscle.	Neck of radius and its bicip. tuberosity and oblique line of radius.	Post. -interosseus (musculo spiral) (5th, 6th, 7th, 8th c. and 1 d. nerves).	5 c. segment.
Extensor secundi internodii pollicis.	Post. surface of shaft of ulna and interosseus membrane.	Base of last phalanx of thumb.	Post. -interosseus (musculo spiral) (5th, 6th, 7th, 8th c. and 1 d. nerves).	
		CARPUS.		
Carpus moved forward by				
Flexor carpi radialis.......	Int. condyle and from fascia of forearm and intermus. septum.	Base of metacarpal bone of index.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Palmaris longus	Int. condyle, deep fascia, and intermuscular septum.	Palmar fascia. Frequently sends a tendinous slip to short muscles of thumb.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.

Flexor digitorum sublimis...	1. Inner condyle and int. lat. lig. of elbow-jt. and inter. septum. 2. Coronoid process ..... 3. Oblique line of radius..	2d phalanges by 4 tendons..	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Flexor carpi ulnaris........	1. Inter. condyle .... 2. Olecranon bet. an aponeurosis from ulna and inter. septum.	Base of 5th metacarpal, unciform bone, annular lig. and pisiform bone.	Ulnar (8 c. and 1 d. nerves).	8 c. segment.
Flexor profundus digitorum..	Shaft of ulna and coronoid proc., post. border of ulna and interosseus membrane.	Base of last phalanges by 4 tendons.	Ulnar and ant. interosseus (8 c. and 1 d. and median).	8 c. segment.
Flexor longus pollicis......	Shaft of radius, interosseus membrane, and sometimes base of coronoid process.	Base of last phalanx of thumb.	Ant. interosseus (median)..	1 d. (?) segment. Four finger breadths above wrist, radial border (m. p.)
Carpus moved backward by				
Extensor carpi radialis longior.	Lower ⅓ ext. condyloid ridge of humerus and intermuscular septum.	Base of metacarpal bone of index finger.	Musculo-spiral (5th, 6th, 7th, 8th c. and 1 d. nerves.	7 c. segment.
Extensor carpi radialis brevior.	Ext. condyloid ridge of humerus, ext. lat. lig. of elbow jt., an aponeurosis and intermuscular septum.	Base of metacarpal bone of middle finger.	Post. interosseus (musculo-spiral).	
Extensor proprius indicis...	Posterior sur. of ulna and interosseus membrane.	2d and 3d phalanges index finger.	Post. interosseus (musculo-spiral).	7 c. segment.
Extensor communis digitorum	Ext. condyle of humerus, deep fascia and intermuscular septum.	All 2d and 3d phalanges...	Post. interosseus (musculo-spiral).	7 c. segment.
Extensor carpi ulnaris..... and Extensors of thumb and fingers.	Ext. condyle of humerus, post. border of ulna, fascia of forearm.	Base of metacarpal of little finger.	Post. interosseus (musculo-spiral).	7 c. segment.
Carpus abducted by				
Extensor carpi radialis longior.	Lower ⅓ ext. condyloid ridge humerus and intermuscular septum.	Base of metacarpal bone of index finger.	Musculo-spiral (5th, 6th, 7th, 8th c. and 1 d. nerves)	7 c. segment.
Extensor carpi radialis brevior.	Ext. condyloid ridge of humerus, ext. lat. lig. of elbow-jt., an aponeurosis and intermuscular septum.	Base of metacarpal bone of middle finger.	Post. interosseus (musculo-spiral) (5th, 6th, 7th, 8th c. and 1 d. nerves).	7 c. segment.
Flexor carpi radialis and Extensors of thumb.	Int. condyle and from fascia of forearm and intermus. septum.	Base of metacarpal bone of index.	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Carpus moved inward by Flexor digitorum sublimis...	1. Inner condyle and int. lat. lig. of elbow-jt. and inter. septum. 2. Coronoid process ..... 3. Oblique line of radius..	2d phalanges by 4 tendons..	Median (5th 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Flexor carpi ulnaris.......	1. Inter. condyle .... 2. Olecranon by an aponeurosis and intermus. septum.	Base of 5th metacarpal, unciform bone, annular lig. and pisiform bone.	Ulnar (8 c. and 1 d. nerves).	8 c. segment.
Flexor profundus digitorum.	Shaft of ulna and coronoid process, post. border of ulna, and interosseous membrane.	Base of last phalanges by 4 tendons.	Ulnar and ant. interosseous (8 c. and 1 d. and median).	8 c. segment.
Extensor communis digitorum.	Ext. condyle of humerus, deep fascia, intermuscular septum.	All 2d and 3d phalanges....	Post. interosseus (musculo-spiral) (5th, 6th, 7th, 8th c. and 1 d. nerves).	7 c. segment.
Extensor minimi digiti.....	From common tendon and intermuscular septa.	2d and 3d phalanges little finger.	Post. interosseus (musculo-spiral).	7 c. segment.
Extensor carpi ulnaris......	Ext. condyle of humerus, and posterior border of ulna, also fascia of forearm.	Base of 5th metacarpal.....	Post. interosseus (musculo-spiral).	7 c. segment.
		THUMB.		
Thumb moved inward and forward across palms by Opponens pollicis	Trapezium and annular lig..	Metacarpal of thumb.......	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	1 d. segment.
Flexor brevis pollicis......	Trapezium, trapezoid, os magnum, base of 2d and 3d metacarpal, annular lig., and tendon flex. carpi radialis.	Base of 1st phalanx of thumb	Median and ulnar (Median and 8 c. and 1 d.).	1 d. segment.
Flexor longus pollicis......	Shaft of radius, interosseous membrane, and occasionally from base of coronoid.	Last phalanx of thumb.....	Ant. interosseous (Median).	Four finger breadths above wrist, radial border (m. p.).

Thumb moved outward and backward by				
Extensor ossis metacarpi pollicis.	Post. surface of shaft of ulna and interosseous lig., and ⅓ of post. surface of shaft of radius.	Base of metacarpal of thumb	Post. interosseus (musculo-spiral) (5th, 6th, 7th, 8th c. and 1 d. nerves).	(1 d) ? segment.
Extensor primi internodii pollicis.	Post. surface of shaft of radius and interosseous membrane.	Base of 1st phalanx of thumb	Post. interosseus (musculo-spiral).	(1 d) ? segment.
Extensor secundi internodii pollicis.	Post. surface of shaft of ulna and interosseous membrane.	Base of last phalanx of thumb	Post. interosseus (musculo-spiral).	(1 d) ? segment.
Thumb moved upward and forward away from other fingers by				
Abductor pollicis	Trapezium and annular ligament.	Base of 1st phalanx of thumb	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	1 d. segment.
Assisted by				
Part of flexor brevis pollicis.	Trapezium, trapezoid, os magnum, base of 2d and 3d metacarpal, annular lig., and sheath of tendon flexor carpi radialis.	Base of 1st phalanx of thumb	Median and ulnar (Median and 8 c. and 1 d. nerves).	1 d. segment.
Thumb moved backward and inward to other fingers by				
Adductor pollicis	Lower ⅔ of metacarpal bone of middle finger.	Base of 1st phalanx of thumb and internal sesamoid bone.	Ulnar (8 c. and 1 d. nerves).	1 d. segment.
Extensor primi internodii pollicis.	Post. surface of shaft of radius and interosseous membrane.	Base of 1st phalanx of thumb	Post. interosseus (Musculo-spiral) (5th, 6th, 7th, 8th c. and 1 d.).	
Extensor secundi internodii pollicis.	Post. surface of shaft of ulna and interosseous membrane.	Base of last phalanx of thumb	Post. interosseus (Musculo-spiral).	
		FINGERS.		
Fingers moved forward or flexed by				
Flexor digitorum sublimis..	1. Inner condyle, and int. lat. lig. of elbow-jt., and intermus. septum. 2. Coronoid process ..... 3. Oblique line of radius..	2d phalanges by 4 tendons..	Median (5th, 6th, 7th, 8th c. and 1 d. nerves).	8 c. segment.
Flexor profundus digitorum.	Shaft of ulna, and coronoid process, post. border of ulna, and interosseous membrane.	Base of last phalanges by 4 tendons.	Ulnar and anterior interosseous (8 c. and 1 d. and median).	8 c. segment.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Lumbricales 4	Tendons of deep flexor....	Tendinous expansion of extensor communis digitorum	Median supplies two outer lumbricales, ulnar supplies the rest of this group. (Median and 8 c. and 1 d. nerves).	8 c. and 1 d. segments.
Interossei, 4 dorsal	From sides of metacarpal bones.	Into base of first phalanges and into aponeurosis of common extensor tendon.		
Interossei, 3 palmar	From metacarpal bones.....	Into side of base of 1st phalanx and aponeurotic expan. of common extensor tendon of same finger.		
Flexor brevis minimi digiti..	Unciform bone, and annular ligament.	Base of 1st phalanx of little finger.	Ulnar (8 c. and 1 d. nerves).	1 d. segment, or 7 c.—1 d. segment.
Abductor minimi digiti.....	Pisiform bone and expansion of tendon of the flexor carpi ulnaris.	Base of first phalanx of little finger.	Ulnar (8 c. and 1 d. nerves).	1 d. segment.
Fingers moved backwards or extended by				
Extensor communis digitorum	Ext. condyle of humerus, deep fascia, and intermuscular septum.	All 2d and 3d phalanges...	Post. interosseous (Musculo-spiral,—5th, 6th, 7th, 8th c. and 1 d. nerves).	7 c. segment.
Extensor minimi digiti.....	From common tendon, and intermuscular septum.	2d and 3d phalanges of little finger.	Post. interosseous (Musculo-spiral).	7 c. segment.
Extensor proprius indicis...	Post. surface of ulna, and interosseous membrane.	2d and 3d phalanges index finger.	Post. interosseous (Musculo-spiral).	7 c. segment.
Fingers moved outward to radial border by				
Abductor indicis (1st dorsal interosseous.	Os trapezium, and metacarpal bone of thumb.	First bone of forefinger....	Ulnar (8 c. and 1 d. nerves).	8 c. and 1 d. segments.
Abductor minimi digiti.....	Pisiform bone, and expansion of tendon of flexor carpi ulnaris.	First phalanx of little finger.	Ulnar (8 c. and 1 d. nerves).	1 d. segment or 7 c.—1 d. segment.
Interossei, 4 dorsal	From sides of metacarpal bone.	Into base of first phalanges and into aponeurosis of common extensor tendon.	Ulnar (8 c. and 1 d. nerves.	8 c. and 1 d. segments.
Interossei, 3 palmar	From metacarpal bones....	Into side of base of first phalanx and aponeurotic expan. of com, extensor tendon of same finger.	....	
Fingers moved inward by				
Abductor minimi digiti.....	Pisiform bone, and expansion of tendon of flexor carpi ulnaris.	Base of first phalanx of little finger.	Ulnar (8 c. and 1 d. nerves).	1 d. segment.

Interossei { 4 dorsal	From sides of metacarpal bone.	Into base of first phalanges and into aponeurosis of common extensor tendon.	Ulnar (8 c. and 1 d. nerves).	8 c. and 1 d. segments.
Interossei { 3 palmar	From metacarpal bone.....	Into side of base of first phalanx and aponeurotic expan. of com. extensor tendon of same finger.	Ulnar (8 c. and 1 d. nerves..	
		THIGH.		
Thigh moved forward by Psoas magnus	Sides of bodies, intervertebral substances, and trans. proc. of last dorsal and all lumbar vertebræ.	Lesser trochanter of femur..	Anterior branches of lumbar nerves.	1 and 2 l. segments.
Iliacus	Iliac fossa, crest, base of sacrum, ilio-lumbar ligament, and ant. sup. and ant. inf. spinous processes of ilium, from the notch between them, and capsule of hip-joint.	Tendon of psoas and oblique line from lesser trochanter to linea aspera.	Anterior crural (2d, 3d and 4th l. nerves).	2 l. segment.
Tensor vaginæ femoris.....	Iliac crest, and ant. sup. spinous process of ilium.	Fascia lata, fascia continued to head of tibia.	Superior gluteal (lumbo-sacral cord,—4th and 5th l. nerves).	
Pectineus	Ilio-pectineal line and surface of bone in front of it and from prolongation of Gimbernat's ligament.	Rough line from trochanter minor to linea aspera.	Ant. crural, obturator, and accessory obturator (2d, 3d and 4th l. nerves).	2, 3 and 4 l. segments.
Adductor longus	Front of pubes............	Middle third of linea aspera of femur.	Obturator (2d, 3d and 4th l. nerves).	2, 3 and 4 l. segments.
Adductor brevis	Outer surface of descending ramus of pubes.	Upper part of linea aspera of femur, and lower part of line from lesser trochanter to linea aspera.	Obturator (2d, 3d and 4th l. nerves).	
Thigh moved backward by Gluteus maximus	Sup. curved iliac line, and part of bone, and crest, immediately behind it—sacrum and coccyx, great sacro-sciatic lig., and aponeurosis of erector spinæ muscle.	Fascia lata, and rough line leading from great trochanter to linea aspera.	Small sciatic and branch from sacral plexus (Usually lower part of sacral plexus).	4 and 5 l. or 1 and 2 s. segments.
Part of gluteus medius.....	Outer surface of ilium bet. sup. and mid. curved lines, outer lip of crest, and gluteal aponeurosis.	Oblique line of outer surface of great trochanter.	Superior gluteal (lumbo-sacral cord,—4th and 5th l. nerves).	3, 4 and 5 l. or 4 and 5 l. segments.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Pyriformis	Front of sacrum, grooves leading from foramina, margin of great sciatic foramen, gt. sacro-sciatic lig.	Upper border of great trochanter.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord,—4th and 5th l. nerves).	5 l. segment.
Obturator internus	Inner side of obturator foramen, inner surface of obturator membrane, and tendinous arch which completes obturator canal.	Upper border of great trochanter.	Sacral plexus (at junction of 1st s. and lumbo-sacral cord).	3 and 4 l. or 4 and 5 l. segments.
Part of adductor magnus	Descending ramus of pubes, and ascending ramus and tuberosity of ischium.	1. Rough line from trochanter to linea aspera. 2. All linea aspera and upper part of its internal bifurcation below. 3. Tubercle above inner condyle of femur.	Obturator and great sciatic (2d, 3d, 4th l. and 1st, 2d, 3d s. and lumbo-sacral cord).	3, 4 and 5 l. segments.
Long head of biceps	Tuberosity of ischium	Outer side of head of fibula and external tuberosity of tibia.	Great sciatic. (Four roots of sacral plexus, 1st, 2d, 3d s. nerves and lumbo-sacral cord—4th and 5th l.).	5 l. and 1 s. segments.
Semitendinosus	Tuberosity of ischium and the adjacent aponeurosis.	Upper part of inner surface of shaft of tibia.	Great sciatic.	5 l. segment.
Semimembranosus	Tuberosity of ischium	Inner tuberosity of tibia	Great sciatic	5 l. and 1 s. segments.
Thigh moved inward by				
Psoas magnus	Sides of bodies, intervertebral substances, and trans. proc. of last dorsal and all lumbar vertebræ.	Lesser trochanter of femur	Anterior branches of lumbar nerves.	1 and 2 l. segments.
Iliacus	Iliac fossa, crest, base of sacrum, ilio-lumbar lig., and ant. sup. and ant. inf. spinous proc. of ilium.	Tendon of psoas and oblique line from lesser trochanter to linea aspera.	Anterior crural (2d, 3d and 4th l. nerves).	2 l. segment.
Pectineus	Ilio-pectineal line and surface of bone in front of it and from prolongation of Gimbernat's ligament.	Rough line of femur from trochanter minor to linea aspera.	Ant. crural, obturator, and accessory obturator (2d, 3d and 4th l. nerves).	2, 3 and 4 l. segments.

Gracilis	Ramus of the pubes and ischium.	Upper part of inner surface of shaft of tibia.	Obturator (2d, 3d and 4th l. nerves).	3, 4 and 5 l. segments.
Adductor longus	Front of pubes	Middle third of linea aspera of femur.	Obturator (2d, 3d and 4th l. nerves).	2, 3 and 4 l. segments.
Adductor brevis	Outer surface of descending ramus of pubes.	Upper part of linea aspera of femur and lower part of line from lesser trochanter to linea aspera.	Obturator (2d, 3d and 4th l. nerves).	2, 3 and 4 l. segments.
Adductor magnus	Descending ramus of pubes and ascending ramus and tuberosity of ischium.	1. Rough line from great trochanter to linea aspera. 2. All linea aspera and upper part of its internal bifurcation below. 3. Tubercle above inner condyle of femur.	Obturator and great sciatic (2d, 3d and 4th l. and 1st, 2d, 3d s., and lumbo-sacral cord).	3, 4 and 5 l. segments.
Obturator externus	Obturator foramen and membrane, and tendinous arch, which completes canal for obturator vessels and nerves.	Digital fossa of femur	Obturator nerve (2d, 3d and 4th l. nerves).	3 and 4 or 5 l. segments.
Quadratus femoris	Tuberosity of ischium	Quadrate line on post. surface of trochanter major.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord,—4th and 5th l.).	5 l. segment.
Thigh moved outward by Tensor vaginæ femoris	Iliac crest, and ant. sup. spinous proc. of ilium.	Fascia lata. Fascia is continued to head of tibia.	Sup. gluteal (lumbo-sacral cord,—4th and 5th l. nerves).	
Gluteus maximus	Sup. curved iliac line and part of bone, and crest, immediately behind it—sacrum and coccyx, gt. sacro-sciatic lig., and aponeurosis of erector spinæ muscle.	Fascia lata and rough line leading from great trochanter to linea aspera.	Small sciatic and branch from sacral plexus. Usually lower part of sacral plexus.	4 and 5 l. or 1 and 2 s. segments.
Gluteus medius	Outer surface of ilium bet. sup. and mid. curved lines, outer lip of crest, and gluteal aponeurosis.	Oblique line of outer surface of great trochanter.	Sup. gluteal (lumbo-sacral cord,—4th and 5th l. nerves).	3, 4 and 5 l. or 4 and 5 l. segments.
Gluteus minimus	Outer surface of ilium bet. mid. and inf. curved lines, margin of great sacro-sciatic notch.	Great trochanter	Sup. gluteal (lumbo-sacral cord,—4th and 5th l. nerves).	3, 4 and 5 l. or 4 and 5 l. segments.
Pyriformis	Front of sacrum, grooves leading from foramina, gt. sciatic foramen, great sacro-sciatic lig.	Upper border of great trochanter.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord).	5 l. segment.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Thigh rotated inward by Tensor vaginæ femoris.....	Iliac crest, and ant. sup. spin. process of ilium.	Fascia lata. Fascia is continued to head of tibia.	Sup. gluteal (lumbo-sacral cord).	High upon the outer border of thigh in front of trochanter. major (m. p.).
Part of gluteus medius..... and	Outer surface of ilium bet. sup. and mid. curved lines, outer lip of crest, and gluteal aponeurosis.	Oblique line of outer surface of great trochanter.	Sup. gluteal (lumbo-sacral cord).	3, 4 and 5 l. or 4 and 5 l. segments.
When the leg is extended by Sartorius	Ant. sup. spinous proc. of ilium and upper half of notch below it.	Upper part of inner surface of shaft of tibia.	Ant. crural (2d, 3d and 4th l. nerves).	2 and 3 l. segments.
Semitendinosus	Tuberosity of ischium, and the adjacent aponeurosis.	Upper part of inner surface of shaft of tibia.	Great sciatic. (Four roots of sacral plexus, 1st, 2d, 3d s. nerves, and lumbo-sacral cord).	5 l. segment.
Thigh rotated outward by Gluteus maximus	Sup. curved iliac line and part of bone, and crest, immediately below it—sacrum and coccyx, gt. sacro-sciatic lig., and aponeurosis of erector spinæ muscle.	Fascia lata and rough line leading from great trochanter to linea aspera.	Small sciatic and branch from sacral plexus. Usually lower part of sacral plexus.	4 and 5 l. or 1 and 2 s. segments.
Part of gluteus medius.....	Outer surface of ilium bet. sup. and mid. curved lines, outer lip of crest, and gluteal aponeurosis.	Oblique line of outer surface of great trochanter.	Sup. gluteal (lumbo-sacral cord,—4th and 5th l. nerves).	3, 4 and 5 l. or 4 and 5 l. segments.
Pyriformis	Front of sacrum, grooves leading from foramina, margin of gt. sciatic foramen, gt. sacro-sciatic lig.	Upper border of great trochanter.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord).	5 l. segment.
Gemellus superior	Ischial spine	Upper border of great trochanter.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord).	5 l. segment.
Obturator internus	Inner side of obturator foramen, inner surface of obturator membrane and tendinous arch which completes obturator canal.	Upper border of great trochanter.	Sacral plexus (at junction of 1st s. and lumbo-sacral cord).	3 and 4 l. or 5 l. segment.

Gemellus inferior	Tuberosity of ischium	Upper border of great trochanter.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord).	5 l. segment.
Quadratus femoris	Tuberosity of ischium	Quadrate line on post. surface of troch. major of femur.	Sacral plexus (1st, 2d, 3d s. nerves and lumbo-sacral cord).	5 l. segment.
Obturator externus	Inner side of obturator foramen, and obturator membrane, and tendinous arch which completes canal for obt. ves. and nerves.	Digital fossa of femur	Obturator (2d, 3d and 4th l. nerves).	3 and 4 or 5 l. segments.
Psoas magnus	Side of bodies, intervertebral sub., and trans. proc. of last dorsal and all lumbar vertebræ.	Lesser trochanter of femur	Anterior branches of lumbar nerves.	1 and 2 l. segments.
Iliacus	Iliac fossa, crest, base of sacrum and ant. sup. and ant. inf. spin. proc. of ilium.	Tendon of psoas and oblique line from lesser trochanter to linea aspera.	Ant. crural (2d, 3d and 4th l. nerves).	1 and 2 l. segments.
Adductor longus	Front of pubes	Middle third of linea aspera of femur.	Obturator (2d, 3d and 4th l. nerves).	2, 3 and 4 l. segments.
Adductor brevis	Outer surface of descending ramus of pubes.	Upper part of linea aspera of femur and lower part of line from lesser trochanter to linea aspera.	Obturator (2d 3d and 4th l. nerves).	
Adductor magnus	Descending ramus of pubes and ascending ramus and tuberosity of ischium.	1. Rough line from gt. trochanter to linea aspera. 2. All linea aspera and upper part of bifurcation below. 3. Tubercle above inner condyle of femur.	Obturator and great sciatic (2d, 3d and 4th l. and 1st, 2d, 3d s. and lumbo-sacral cord).	3, 4 or 3, 4 and 5 l. segments.
Biceps cruris, slightly	Long head—Ischial tuberosity. Short head—Out. lip of linea aspera. Ext. supracondyloid line, ext. intermus. septum.	Outer side of head of fibula, ext. tuberosity of tibia.	Great sciatic. (Four roots of sacral plexus, 1st, 2d, 3d s. nerves, and lumbo-sacral cord).	5 l. and 1 s. segments.
		LEG.		
Leg moved backward or flexed by				
Semitendinosus	Tuberosity of ischium and the adjacent aponeurosis.	Upper part of inner surface of shaft of tibia.	Great sciatic	5 l. segment.
Biceps	Long head—Tuberosity of ischium. Short head—Outer lip of linea aspera, Ext. supra-condyloid line, external intermuscular septum.	Outer side of head of fibula, and ext. tuberosity of tibia.	Great sciatic	5 l. and 1 s. segments.

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Semimembranosus	Tuberosity of ischium	Inner tuberosity of tibia	Great sciatic	5 l. and 1 s. segments.
Gracilis	Ramus of the pubes and ischium.	Upper and inner surface of shaft of tibia.	Obturator (2d, 3d and 4th l. nerves).	3, 4 and 5 l. segments.
Sartorius	Ant. sup. spinous proc. of ilium and half of notch below it.	Upper part of inner surface of shaft of tibia.	Ant. crural (2d, 3d and 4th l. nerves).	2 and 3 l. segments.
Popliteus	Ext. condyle of femur, and post. lig. of knee-joint.	Post. surface of shaft of tibia above oblique line and into ten. expan. covering the surface of the muscle.	Int. popliteal (Great sciatic).	5 l. segment.
Leg extended by				
Rectus femoris	Short head—Ant. inf. spin. process of ilium. Long head—Groove above brim of acetabulum.	Patella	Anterior crural (2d, 3d and 4th l. nerves).	2 and 3 l. segments.
Crureus and vastus internus.	Line from inner side of neck of femur to linea aspera, shaft of femur, inner lip of linea aspera, a ridge from linea aspera to int. condyle and intermuscular septum.	Patella	Anterior crural (2d, 3d and 4th l. nerves).	2 and 3 l. segments.
Vastus externus	Tubercle of femur, ant. border great trochanter, its outer surface, and linea aspera, and rough line from troch. major to linea aspera, tendon of gluteus maximus, and ext. intermuscular septum.	Outer border of patella	Anterior crural (2d, 3d and 4th l. nerves).	2 and 3 l. segments.
		FOOT.		
Foot moved forward or flexed by				
Tibialis anticus	Outer tuber., and upper part of ext. surface of shaft of tibia, interosseous mem., deep surface of fascia, and intermuscular septa.	Int. cuneiform bone and base of metatarsal bone of great toe.	Ant. tibial (Ext. popliteal wh. is from great sciatic).	4 or 5 l. and 1 s. or 2 s. segments.

Extensor proprius pollicis...	Ant. surface of mid. of fibula, and interosseous membrane.	Base of last phalanx of great toe.	Ant. tibial (Ext. popliteal)..	5 l. and 1 s. segments.
Extensor longus digitorum..	Outer tuberosity of tibia, ant. surface of shaft of fibula, interosseous membrane, deep surface of fascia, and intermuscular septa.	2d aud 3d phalanges of the 4 lesser toes.	Ant. tibial (Ext. popliteal)..	5 l. and 1 s. segments.
Peroneus tertius	Lower ¼ of ant. surface of fibula, interosseous membrane, and intermuscular septa.	Base of metatarsal bone of little toe.	Ant. tibial (Ext. popliteal)..	5 l. and 1 s. or 2 and 3 s. segments.
Foot moved backward or extended by				
Gastrocnemius	Int. condyle, and ext. condyle of femur, aud ridges from condyles to linea aspera.	Os calcis by tendo Achilles..	Int. popliteal (Great sciatic).	5 l. or 1 and 2 s. segments.
Plantaris	Outer bifurcation of linea aspera, and post. lig. of knee-joint.	Post. surface of os calcis...	Int. popliteal (Great sciatic).	5 l. segment.
Soleus	Shaft and head of fibula, oblique line of tibia, and mid. third of its internal border, and tendinous arch.	Os calcis by tendo Achilles..	Int. popliteal (Great sciatic).	5 l. segment.
Flexor longus digitorum....	Post. surface of shaft of tibia, and intermus. septum.	Bases of last phalanges of the 4 lesser toes.	Post. tibial (Int. popliteal)..	5 l.—2 s. segment.
Flexor longus pollicis......	Lower ⅔ of post. surface of shaft of fibula, except 1 in. at its lowest part, interosseous mem., intermus. septum, and fascia covering the tibialis posticus.	Base of last phalanx of great toe.	Post. tibial (Int. popliteal)..	5 l.—2 s. segment.
Tibialis posticus	Post. surface of shaft of tibia, upper ⅔ of int. sur. of fibula, deep transverse fascia, intermuscular septa, and post. surface of interosseous membrane.	Tuberosity of scaphoid and int. cuneiform.	Post. tibial (Int. popliteal)..	1 and 2 s. segments.
Peroneus longus	Head and ⅔ of ext. sur. of shaft of fibula, deep surface of fascia, intermuscular septa.	Base of 1st metatarsal bone of great toe, and int. cuneiform bone, occasionally the base of second metatarsal bone.	Musculo-cutaneous (Ext. popliteal from great sciatic).	5 l. and 1 s. or 2 and 3 s. segments.
Peroneus brevis	Lower ⅔ of ext. sur. of shaft of fibula, and intermuscular septa.	Base of metatarsal bone of little toe.	Musculo-cutaneous	5 l. and 1 s. or 2 and 3 s. segments.

ACTION OF GROUPS OF MUSCLES — Continued.

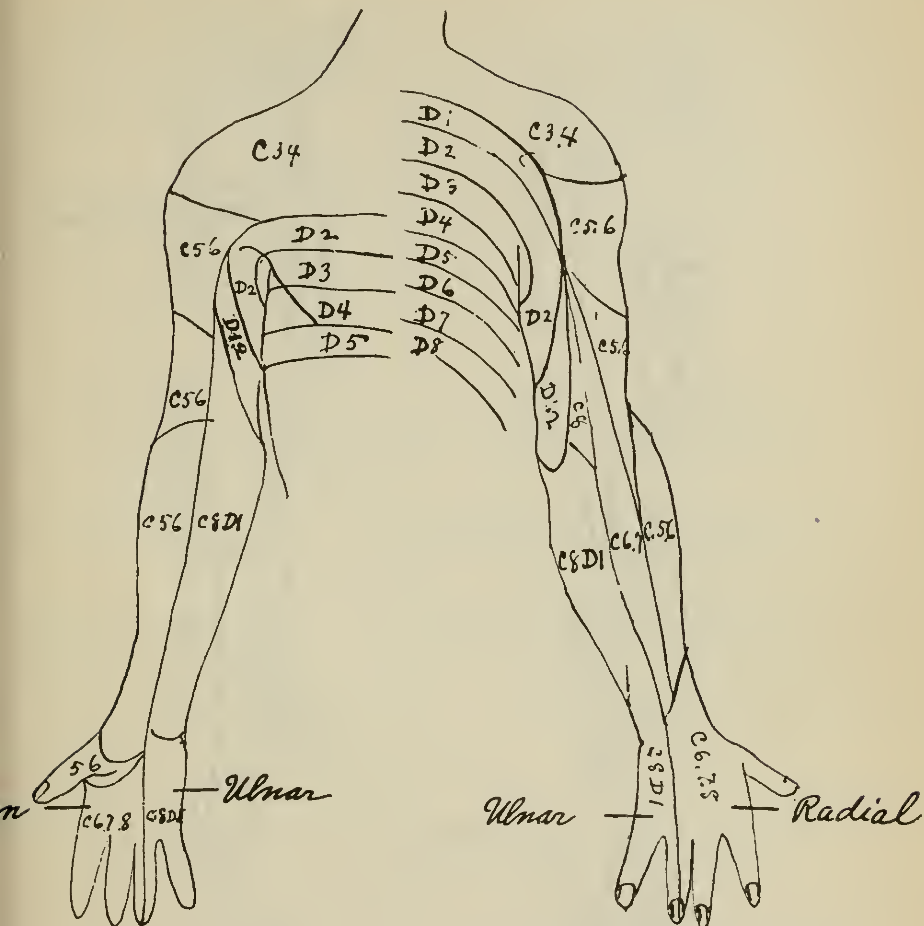
MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Foot inclined inward by				
Extensor proprius pollicis...	Ant. surface of mid. of fibula, and interosseous membrane.	Base of last phalanx of great toe.	Ant. tibial (Ext. popliteal from great sciatic).	5 l. and 1 s. segments.
Flexor longus digitorum....	Post. surface of shaft of tibia, and intermuscular septum.	Bases of last phalanges of the 4 lesser toes.	Post. tibial (Int. popliteal from great sciatic).	5 l.—2 s. segment.
Flexor longus pollicis......	Lower ⅔ of post. sur. of shaft of fibula, except 1 in. at its lowest part, inteross. mem., intermus. septum, and fascia covering tibialis post.	Base of last phalanx of great toe.	Post tibial (Int. popliteal)..	5 l.—2 s. segment.
Tibialis posticus	Post. surface of shaft of tibia, upper ⅔ of int. sur. of fibula, deep transverse fascia, intermuscular septa, and post. surface of interosseous membrane.	Tuberosity of scaphoid and int. cuneiform.	Post tibial (Int. popliteal)..	1 and 2 s. segments.
Foot moved outward by				
Peroneus longus	Head and ⅔ of ext. sur. of shaft of fibula, deep surface of fascia, intermus. septa.	Base of metatarsal bone of great toe and int. cuneiform. Occasionally the base of second metatarsal bone.	Musculo-cutaneous (Ext. popliteal from great sciatic).	5 l. and 1 s. or 2 and 3 s. segments.
Peroneus brevis	Lower ⅔ of ext. surface of shaft of fibula, intermuscular septa.	Base of metatarsal bone of little toe.	Musculo-cutaneous	5 l. and 1 s. or 2 and 3 s. segments.
Extensor longus digitorum..	Outer tuberosity of tibia, shaft of fibula, interosseous mem., deep surface of fascia, and intermus. septa.	2d and 3d phalanges of the 4 lesser toes.	Ant. tibial (Ext. popliteal from great sciatic).	5 l. and 1 s. segments.
Peroneus tertius	Lower ¼ of ant. surface of fibula, interos. mem., and intermus. septa.	Base of metatarsal bone of little toe.	Ant. tibial	5 l. and 1 s. or 2 and 3 s. segments.

TOES.

Toes moved backward or flexed by				
Abductor pollicis	Inner tubercle os calcis, int. annular lig., plantar fascia, and intermuscular septum.	Base of first phalanx of great toe.	Int. plantar (Post. tibial from int. popliteal).	1 and 2 s. segments.
Flexor brevis digitorum	Inner tub. of os calcis, plantar fascia, intermus. septa.	Second phalanges of lesser toes.	Int. plantar.	
Abductor minimi digiti	Outer tubercle and under sur. of os calcis, inner tubercle, plantar fascia, and intermuscular septum.	Base of first phalanx of little toe.	Ext. plantar (Post. tibial from int. popliteal).	1 and 2 s. or 2 and 3 s. segments.
Flexor longus pollicis	Lower ⅔ of post. sur. of shaft of fibula, except 1 in. at its lowest part, interos. mem., intermus. septum, and fascia covering the tibialis posticus.	Base of last phalanx of great toe.	Post. tibial (Int. popliteal from great sciatic).	5 l.—2 s. segment.
Flexor longus digitorum	Post. surface of shaft of tibia, and intermus. septum.	Bases of last phalanges of 4 lesser toes.	Post. tibial	5 l.—2 s. segment.
Flexor accessorius	1. Inner sur. of os calcis and calcaneo-scaphoid ligament. 2. Under surface of os calcis.	Tendon of flexor longus digit.	Ext. plantar (Post. tibial from int. popliteal).	1 and 2 s. or 2 and 3 s. segments.
Lumbricales 4	Tendons flexor longus	Expansion of long extensor and base of first phalanx of corresponding toe.	Two inner—Int. plantar (Post. tibial). Two outer—Ext. plantar (Post. tibial).	1 and 2 s. segments.
Flexor brevis pollicis	Cuboid and ext. cuneiform bone, and prolongation of tendon of tibialis posticus.	Base of first phalanx of great toe.	Int. plantar	1 and 2 s. segments.
Adductor pollicis	Tarsal ends of 2d, 3d and 4th metatarsal bones and sheath of tendon of peroneous longus.	Base of first phalanx of great toe.	Ext. plantar	1 and 2 s. segments.
Flexor brevis minimi digiti	Base of metatarsal bone of little toe and sheath of peroneus longus.	Base of first phalanx of little toe.	Ext. plantar (Post tibial from int. popliteal).	1 and 2 s. or 2 and 3 s. segments.
Interossei — 4 dorsal	From adjacent sides of two metatarsal bones.	Base of first phalanx of corresponding toe and aponeurosis of common extensor tendon.	Ext. plantar	1 and 2 s. segments.
Interossei — 3 plantar	From shafts of 3d, 4th, and 5th metatarsal bones.	Bases of first phalanges of same toes and aponeurosis of common extensor tendon	Ext. plantar	

ACTION OF GROUPS OF MUSCLES — Continued.

MUSCLE.	ORIGIN.	INSERTION.	NERVE SUPPLY.	REPRESENTED IN.
Toes moved forward or extended by				
Extensor longus digitorum..	Outer tuberosity of tibia, shaft of fibula, interos. mem., deep surface of fascia, and intermus. septa.	2d and 3d phalanges of the 4 lesser toes.	Ant. tibial (Ext. popliteal from great sciatic).	5 l. and 1 s. segments.
Extensor proprius pollicis...	Ant. surface of middle of fibula, and interosseous membrane.	Base of last phalanx of great toe.	Ant. tibial	5 l. and 1 s. segments.
Extensor brevis digitorum..	Os calcis, ext. calcaneo astragaloid lig., and ant. annular ligament.	First phalanx of great toe and long extensor tendons of 2d, 3d, and 4th toes.	Ant. tibial	1 and 2 s. or 2 and 3 s. segments.
Toes inclined inward by				
Abductor pollicis	Inner tubercle of os calcis, int. annular lig., plantar fascia, and intermuscular septa.	Base of first phalanx of great toe.	Int. plantar (Post tibial from int. popliteal).	1 and 2 s. segments.
Interossei { 4 dorsal	From adjacent sides of two metatarsal bones.	Base of first phalanx of corresponding toe and aponeurosis of common extensor tendon.	Ext. plantar (Post tibial from int. popliteal).	1 and 2 s. segments.
Interossei { 3 plantar	From shafts of 3d, 4th, and 5th metatarsal bones.	Bases of first phalanges of same toes and aponeurosis of common extensor tendon	Ext. plantar	
Toes moved outward by				
Abductor pollicis	Inner tubercle of os calcis, int. annular lig., plantar fascia, and intermuscular septa.	Base of first phalanx of great toe.	Int. plantar (Post tibial from int. popliteal).	1 and 2 s. segments.
Interossei { 4 dorsal	From adjacent sides of two metatarsal bones.	Base of first phalanx of corresponding toe and aponeurosis of common extensor tendon.	Ext. plantar (Post tibial from int. popliteal.	1 and 2 s. segments.
Interossei { 3 plantar	From shafts of 3d, 4th, and 5th metatarsal bones.	Bases of first phalanges of same toes and aponeurosis of common extensor tendon	Ext. plantar	
Abductor minimi digiti.....	Outer tubercle and under surface of os calcis, inner tubercle, plantar fascia, and intermuscular septa.	Base of first phalanx of little toe.	Ext. plantar	1 and 2 s. or 2 and 3 s. segments.



g. 33.—Distribution of cutane-ous nerves on the front of the pper limb showing the spinal rigin of the nerves to each rea. (After Despard.)

Fig. 34.—Distribution of cutane-ous nerves on the back of the upper limb showing the spinal origin of the nerves to each area. (After Despard.)

It seems to the author that since it has been demonstrated that a specified spinal segment does not correspond in its relation to the same vertebra in all persons, while the exits are so far as known universally uniform in site it would be preferable in

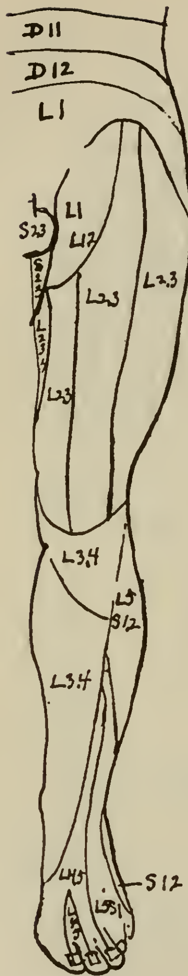


Fig. 35.—Distribution of cutaneous nerves on the front of the lower limb showing the spinal origin of the nerves supplying each area. (After Despard.)

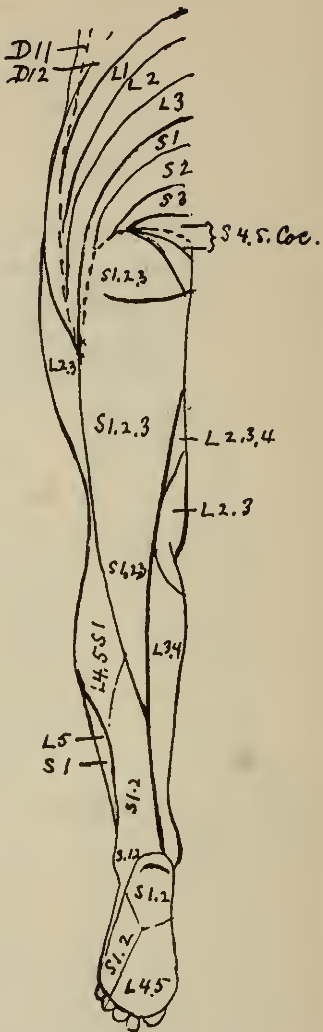


Fig. 36.—Distribution of cutaneous nerves on the back of the lower limb showing the spinal origin of the nerves to each area. (After Despard.)

the study and interpretation of disease and referred pain to note the vertebral exit of the affected nerve instead of noting its segment as is customary.

When a part is affected "the indications* to be found on examination correspond to the *exit* of the spinal nerve and not to the location of the *segment* of the cord in the spinal canal. For example, the sacral segments of the cord are located about the 2nd or 3rd lumbar vertebrae, but the indications are found over the sacrum at the exit of the nerve or in the muscle supplied by it."

A Table of Segmental Localization is found on page 110.

The following table is from Thorburn† (modified) and is founded entirely upon clinical data, doubtful muscles being excluded:

Supraspinatus, Teres Minor (?)	Fourth cervical nerve. Exit between 3rd and 4th cervical vertebrae.
Biceps, Brachialis anticus, Deltoid, Supinator longus, Supinator brevis (?)	Fifth cervical nerve. Exit between 4th and 5th cervical vertebrae.
Subscapularis, Pronators, Teres Major, Latissimus dorsi, Pectoralis major, Triceps, Serratus magnus,	Sixth cervical nerve. Exit between 5th and 6th cervical vertebrae.
Extensors of the wrist,	Seventh cervical nerve. Exit between 6th and 7th cervical vertebrae.
Flexors of the wrist,	Eighth cervical nerve. Exit between 7th cervical and 1st dorsal vertebrae.
Interossei, Other intrinsic muscles of the hand,	First dorsal nerve. Exit between 1st and 2nd dorsal vertebrae.

* Arnold. The Importance of the Physical Examination of the Back in General Diagnosis. *Medical News*, March 18, 1905.

† Moullin's Treatise on Surgery. Hamilton, page 692.

Plate VII. (Howell) is a more elaborate diagrammatic illustration of the relation of the spinal segments to localities supplied by sensory neurons and muscles as well as some reflexes.

The relation between the segments of the spinal cord and reflex responses is considered in Chapter IV page 72, and in Chapter XI is given the *segmental distribution of referred pain and tenderness in visceral diseases* which is of importance in the study of disease diagnostically and therapeutically. Figs. 33, 34, 35, 36, and 37 give the distribution of cutaneous nerves with reference to spinal origin. Skin areas referring to different spinal segments are represented in Plates IX and X.

Fig. 37.—Cutaneous areas of the head and neck supplied by the 2nd, 3rd, and 4th cervical segments of the spinal cord. (Butler's Diagnostics of Internal Medicine. D. Appleton & Co.)

In the employment of mechanical vibration for diagnostic purposes oftimes pain or reflexes are elicited, referable to these areas.

When the skin is sensitive by referring to Plates IX. and X. (Head) and noting the nerve segment corresponding to the sensitive area, and then noting with what vertebrae this segment is related and concussing or vibrating these vertebrae, or corresponding intervertebral spaces for a few minutes, an analgesic effect will be produced.

Plate VII.—Diagrammatic Representation of the Lower Portion of the Human Bulb and Spinal Cord. (Howell's Text-Book of Physiology. W. B. Saunders Co.)

The cord is divided into its four regions: 1, Medulla cervicalis; 2, medulla dorsalis; 3, medulla lumbalis; 4, medulla sacralis. With each region the spinal segments bear Roman numbers. On the left side of the diagram the locality supplied by the sensory (afferent) neurons is indicated by one or more words, and these latter are connected with the bulb or the segments of the cord at the levels at which the nerves enter. The afferent character is indicated by the arrow tip on the lines of reference.

On the right-hand side the names of muscles or groups of muscles are given, and to them are drawn reference lines which start from the segments of the cord in which the cell-bodies of origin have been located.

Within the cord itself, the designations for several reflex centers are inscribed in the segment where the mechanism is localized. For example, Reflexus scapularis, Centrum cilio-spinale, Reflexus epigastricus, Reflexus abdominalis, Reflexus cremastericus, Reflexus patellaris, Reflexus tendo Achillis, Centrum vescicale, Centrum anale (the last two on the left side of the diagram). (Donaldson, "Amer. Text-Book of Physiology," from "Icones Neurologicæ," Strumpell and Jakob.)

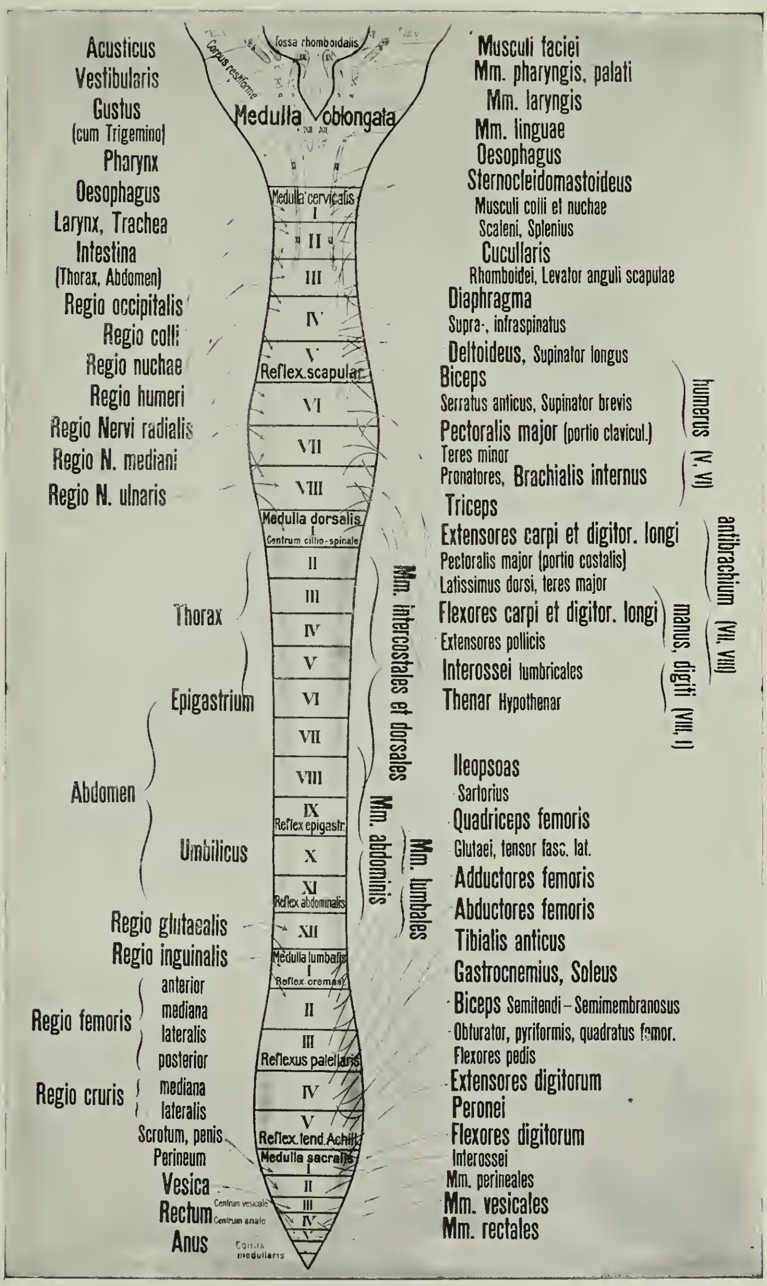

Acusticus
Vestibularis
Gustus
(cum Trigemino)
Pharynx
Oesophagus
Larynx, Trachea
Intestina
(Thorax, Abdomen)
Regio occipitalis
Regio colli
Regio nuchae
Regio humeri
Regio Nervi radialis
Regio N. mediani
Regio N. ulnaris
Thorax
Epigastrium
Abdomen
Umbilicus
Regio glutaealis
Regio inguinalis
Regio femoris
anterior
mediana
lateralis
posterior
Regio cruris
mediana
lateralis
Scrotum, penis
Perineum
Vesica
Rectum
Anus
fossa rhomboidalis
Corpus restiforme
Medulla oblongata
Medulla cervicalis
I
II
III
IV
V
Reflex. scapular.
VI
VII
VIII
Medulla dorsalis
I
Centrum cilio-spinale
II
III
IV
V
VI
VII
VIII
IX
Reflex epigastr.
X
XI
Reflex abdominalis
XII
Medulla lumbalis
I
Reflex cremas.
II
III
Reflexus patellaris
IV
V
Reflex. tend. Achill.
Medulla sacralis
I
II
III
IV
V
Centrum vesicale
Centrum anale
Conus medullaris
Mm. intercostales et dorsales
Mm. abdominis
Mm. lumbales
Musculi faciei
Mm. pharyngis, palati
Mm. laryngis
Mm. linguae
Oesophagus
Sternocleidomastoideus
Musculi colli et nuchae
Scaleni, Splenius
Cucullaris
Rhomboidei, Levator anguli scapulae
Diaphragma
Supra-, infraspinatus
Deltoideus, Supinator longus
Biceps
Serratus anticus, Supinator brevis
Pectoralis major (portio clavicul.)
Teres minor
Pronatores, Brachialis internus
Triceps
Extensores carpi et digitor. longi
Pectoralis major (portio costalis)
Latissimus dorsi, teres major
Flexores carpi et digitor. longi
Extensores pollicis
Interossei lumbricales
Thenar Hypothenar
humerus (V, VI)
antibrachium (VII, VIII)
manus, digiti (VIII, I)
Ileopsoas
Sartorius
Quadriceps femoris
Glutaei, tensor fasc. lat.
Adductores femoris
Abductores femoris
Tibialis anticus
Gastrocnemius, Soleus
Biceps Semitendi-Semimembranosus
Obturator, pyriformis, quadratus femor.
Flexores pedis
Extensores digitorum
Peronei
Flexores digitorum
Interossei
Mm. perineales
Mm. vesicales
Mm. rectales

Plate VII.

In the study of segmental analgesia it has been found* that:

"1. Concussion and sinusoidalization stimulate the motor component of a spinal segment and subdue its sensory constituent.

"2. The sensory component of a normal spine segment is less amenable to concussion, sinusoidalization and freezing than a hyperesthetic segment."

Abrams also noted the association of definite spinal segments† associated with visceral sensation.

In his study of the reflexes he found that the physiological location of viscero-motor cells did not correspond with the clinical localization of the viscero-motor reflexes but, to make the work more complete, the following table is appended.

"The viscero-motor cells control involuntary muscles aside from those of the vascular walls."‡

Table of Viscero-Motor Neurons

Cause constriction of pupil.	In nucleus of the 3rd cranial nerve.
Dilator cells for pupil.	Chiefly between the 6th cervical and 1st or 2nd dorsal.
Viscero-motor of constrictor type for bronchi and bronchioles.	In nucleus of the 10th cranial.
Probably there is a dilator type for bronchi and bronchioles.	Between the 3rd and 7th dorsal segments. Arnold states that proper manipulation of these segments will relax bronchial spasm.
Inhibitory neural cells of neurons for heart.	In nuclei of the 10th and 11th cranial nerves and send their paths to the heart through the 10th nerve.
Accelerating set of neurons for heart.	Chiefly from the 6th cervical to the 1st or 2nd dorsal segments.

* Abrams. Spondylotherapy, page 367.

† Abrams. Spondylotherapy, page 377.

‡ Arnold. The Importance of the Physical Examination of the Back in General Diagnosis. *Medical News*, March 18, 1905.

Accelerating cells for oesophagus, stomach, small intestine, and probably ascending part of large intestine.	Chiefly in nucleus of the 10th cranial nerve; possibly, also, in the 11th. Their paths are distributed through the 10th.
Inhibitory neural cells for oesophagus, stomach, small intestine, probably ascending part of large intestine.	Chiefly in spinal cord segments corresponding to vasoconstrictor neural cells supplying the parts named in bracket to left. Probably some inhibitory paths in the 10th cranial and some accelerators in cord.
Inhibitory cells of muscular coat of Fallopian tubes and uterus, with contraction of cervix, vagina, and perineum.	Chiefly in the 2nd, 3rd, and 4th lumbar segments.
Constriction of Fallopian tubes, the muscular coat of uterus, with dilatation of cervix, vagina and perineum.	In the 2nd, 3rd and 4th sacral segments.
Inhibition of muscular coat of bladder with contraction of sphincter of bladder.	In the 2nd, 3rd and 4th lumbar segments.
Contraction of muscular coat of bladder with relaxation of sphincter of bladder.	In the 2nd, 3rd and 4th sacral segments.
Neural cells for external sphincter.	Probably in the last sacral and to some extent in coccygeal segment.
The mechanism of rectum and its internal sphincter is similar to that of the bladder and occupy practically corresponding segments of the cord.	

The genitals are supplied* with two kinds of nerves; spinal (cervix, vagina and pudendum) and sympathetic (corpus, fundus, oviduct and ovary). The cervix is supplied by the second, third, and fourth sacral.

Freese† claims that "the musculature of the gall-bladder is provided with motor (constrictor) and

* Byron Robinson. The Pelvic Brain, Medical Brief.

† Johns Hopkins Hospital Bulletin, June, 1905.

inhibitory (dilator) nerve fibres which come "from the spinal cord in the roots of the 6th to the 13th dorsal nerves. The maximum outflow for the constrictor fibres is in the 10th, 11th and 12th dorsal nerves. The dilator fibres appear slightly higher up and are most in evidence from the 8th to the 12th dorsal nerve inclusive." This was demonstrated on animals.

Arnold* found that "repeated brief pressure along the spinal column arouses the reflex constrictor nerves and brings about a certain amount of contraction in the blood vessels of the skin and muscles of the back in the region of the back treated. It also undoubtedly produces at the same time a certain amount of dilatation of the vessels in the cord. On the other hand, continuous pressure along the spine arouses the reflex dilators and brings about a certain amount of dilatation of the blood vessels in the skin and muscles of the back and a corresponding contraction of the blood vessels in the cord."

"Arnold and Ludlum† found that the areas of vertebral tenderness correspond to the vaso-motor centers in the spinal cord and that there exists a compensatory relationship between the blood vessels of the cord and those structures supplied by the posterior primary divisions of the spinal nerves" but Abrams observes that "the nerves merely transmit the stimuli to the gray matter of the spinal cord (section of which abolishes sensations of pain without affecting the tactile sensations), whereby through summation they produce changes in the cells of the gray matter. Such changes are identified with hyper-

* Arnold. Some of the Principles of Manual Therapy. Its Application by the Physician. *New York Medical Journal* and *Philadelphia Medical Journal*, May 13, 1905.

† Abrams. Spondylotherapy, page 72.

aesthesia and hence the vertebral tenderness." In diseases of the viscera there may be present vasomotor, sensory reflexes and motor symptoms induced by paralysis or irritation.

Since the study of the spine and spinal nerves affords an extensive field for investigation in the interpretation of diagnostic findings and in the selection of therapeutic treatment in the management of pathological conditions presented, a table of the vasoconstrictors and vasodilators (Arnold) is given to complete the foundation material offered in this chapter.

TABLE OF THE VASOCONSTRICTOR NEURAL CELLS*

Brain. Face. Scalp. Eye. Mucous membrane of nose. Mouth. Pharynx. Tonsils. Larynx. Salivary glands.	In the 2nd, 3rd, 4th dorsal segments.
Oesophagus. Stomach.	In the 4th to the 9th dorsal segment.
Pancreas. Spleen. Suprarenals.	In the 8th to the 12th dorsal segment with some in segments above the 8th.
Small intestines.	From the 6th dorsal to the 2nd lumbar segment.
Liver.	From the 6th dorsal to the 1st lumbar segment, but chiefly in the 10th, 11th, and 12th dorsal segments.
Large intestine.	From the 11th dorsal to the 2nd lumbar segment.
Lungs and bronchi (for bronchial arteries).	Probably in the 3rd to the 7th dorsal segment.

* Arnold. The Importance of the Physical Examination of the Back in General Diagnosis. *Medical News*, March 18, 1905.

Bladder. External organs of generation. Uterus. Fallopian tubes, Ovaries, Testicles, Prostate gland.	Chiefly from the 11th dorsal to the 2nd lumbar segment, probably occasionally in the 3rd and 4th lumbar segments.
External organs of generation. Skin of ano-genital region.	In the 2nd and 3rd lumbar segments.

TABLE OF VASODILATOR NEURAL CELLS*

Face and scalp.	In nuclei of 7th and 9th cranial nerves.
Eye.	Chiefly in nucleus of the 3rd cranial, probably also in nuclei of the 3rd and 6th.
Mucous membrane of nose, Hard palate, Soft palate, Mucous membrane of the upper lip and upper gums. Submaxillary and sublingual glands.	In nucleus of the 7th cranial.
Parotid glands. Floor of mouth. Lower lip. Mucous membrane of the cheeks, the lower gums, and the tongue.	In nucleus of the 9th cranial.
Lungs and bronchi (for bronchial arteries which supply nourishment to bronchi and lungs).	Probably in the 3rd to the 7th dorsal segment of cord.
Stomach. Small intestines. Liver. Pancreas. Suprarenals. Spleen. Probably first half of large intestine.	In nucleus of the 10th cranial nerve.
Fallopian tubes. Uterus. Ovaries. Testicles.	Chiefly in the 3rd, 4th and 5th sacral segments.

* Arnold. The Importance of the Physical Examination of the Back in General Diagnosis. *Medical News*, March 18, 1905.

Bladder. External organs of generation. Skin of ano-genital region.	In the 3rd and 4th sacral segments.

The reflexes elicited from concussion of the spinous processes or from vibration of the intervertebral spaces, are denominated by Abrams as vertebral reflexes. They open a field of wide study not only in diagnosis but in therapeutics. They are of prime importance in spondylotherapy, as first systematized by Abrams, in a study which has broadened the field of medicine, both as concerns diagnosis and therapeutics.

For diagnosis the vibrator, the sinusoidal current, the static wave current, the static spark, or concussion by means of a plexor with rubber as a pleximeter, a pneumatic hammer or electro-concussor are used. The author employs concussion, mechanical vibration, the static spark, the static wave current, and the sinusoidal current as mechanical means of inducing reflexes. Some of the reflexes are best excited by the sinusoidal current; others, by mechanical vibration or concussion, and some by the static spark or the static wave current localized over the vertebrae or the organ or part in question.

The muscle reflexes respond better generally to the sinusoidal or the static current. Some of the muscle reflexes respond to mechanical vibration whereas others do not unless pathologically affected.

The visceral reflexes respond readily to mechanical vibration. The vibrator used by the author gives a distinct percussion stroke, and the speed employed for this purpose is of moderate frequency.

The method employed for vertebral concussion is as follows: Dust the surface with talcum powder over the site, hold a strip of rubber belting, linoleum, or sole leather to protect the skin over the bone.

With the ball vibratode regulate the vibration to a slow rate of speed, and apply moderate pressure, vibrating or concussing directly over the spinous process of the vertebra indicated, with interruptions from time to time steadying the vibratode with the left index finger and thumb. Care must be exercised to avoid too great friction of the surface if vibration is used in order to avoid abrasion. The length of time varies with the reflex sought. Experience seems to show that the length of application varies also with the structure of the individual and the organ involved. The patient may sit or lie during the seance. The spinous processes are usually more easily found when the patient sits. The reflexes can be elicited also by intervertebral vibration which will be considered later.

The following reflexes were noted by Abrams in his use of concussion and in many instances have been elicited by the author by mechanical vibration, usually applied between the transverse processes of the vertebrae.

TABLE OF REFLEXES*

Reflex.	*Position.*	*Concuss or Vibrate Spinous Processes of.*
Muscular reflexes		
Sterno-cleido-mastoid	Head flexed.	7th c. vertebrae.
Biceps, triceps and wrist jerk.	Upper extremities flexed. Muscles relaxed.	5th and 6th c. vertebrae.
Pectoral.	Lie on side. Arms elevated.	3rd to 6th vertebra.
Scapular.		5th c. vertebrae.
Epigastric.		7th to 9th d. vertebra.
Gluteal.	Lie on side.	Any l. vertebrae.
Cremasteric.		1st, 2nd and 3rd l. vertebrae.
Adductor.	Sit. Lower extremities extended and relaxed.	Lumbar vertebrae.

* Abrams. Spondylotherapy.

Visceral reflexes

Heart reflex of contraction. (May also be caused by nasal, pharyngeal or laryngeal irritation, dilated stomach, rectal irritation.) Present in cardiectasis but absent in pericardial effusions. If an intra-thoracic mass gives heart reflex it is the heart and not an aneurysm.	7th c. vertebra or intervertebral space between 7th c. and 1st d. vertebrae.
Heart reflex of dilatation.	9th, 10th, 11th, 12th d. vertebrae or corresponding intervertebral spaces.
If 2nd and 3d d. concussed and blood pressure is not lowered and the 7th c. is concussed and blood pressure is lowered, it shows that cardiac weakness was associated with the high pressure. (Abrams.)	2nd and 3rd d. vertebrae or corresponding intervertebral space or between 3rd and 4th, or 4th and 5th to lower blood pressure.
Empirically blood pressure raised.	6th and 7th d. vertebrae or corresponding intervertebral space.
If heart feeble and vaso-motors do not compensate. (Abrams.)	7th c. ver. Intervertebral space between 7th c. and 1st dorsal to raise pressure.
Aortic reflex of contraction (thoracic aorta).	7th c. vertebra.
Aortic reflex of dilatation (thoracic aorta). If resulting dulness exceeds the normal, dilatation or aneurysm is present. Normal transverse dulness at level of manubrium is 5 cm. If an aneurysm, the concussion of the 7th c. vertebra will cause area of dulness to be diminished and concussion of 9th to 12th d. will increase the area. Symptoms of aneurysm aggravated by concussion of 9th to 12th d.	9th, 10th, 11th, 12th d. vertebrae or corresponding intervertebral spaces.
Abdominal aortic reflex of contraction.	7th c. vertebra or intervertebral space between 7th c. and 1st d. vertebrae.
Abdominal aortic reflex of dilatation. If at 12th dorsal vertebra, dulness is more than 6 cm. across after elicitation of reflex, dilatation or aneurysm exist.	9th to 12th d. vertebrae or intervertebral spaces between the 9th and 12th d. vertebrae.

Lung reflex of contraction.	4th and 5th c. vertebrae or intervertebral space between 4th and 5th c. vertebrae.
Lung reflex of dilatation. If dulness due to consolidation, lung reflex will not affect it. If opacity is due to atelectasis, lung reflex will affect it. Absence of, posteriorly, is early sign of pulmonary tuberculosis.	3rd to 8th d. vertebra or corresponding intervertebral spaces.
Stomach reflex of contraction. Localizes pain. Determines presence of growth and its relation to the stomach. If sensitive area in epigastrium or growth be shifted up by stomach reflex of contraction and afterwards return to its former site, diagnosis is made of its association with the stomach.	1st, 2nd and 3rd l. vertebrae or intervertebral spaces between the 1st and 2nd and 2nd and 3rd l. vertebrae.
Stomach reflex of dilatation. Abrams notes that the stomach reflex determines the presence of a growth. Reflex of contraction dislocates growth upward and to left; reflex of dilatation dislocates growth downward.	11th d. vertebra.
Liver reflex of contraction.	1st, 2nd and 3rd l. vertebrae or intervertebral spaces between the 1st and 2nd and 2nd and 3rd l. vertebrae.
Liver reflex of dilatation.	11th d. vertebra.
Intestinal reflex of contraction.	1st, 2nd and 3rd l. vertebrae or intervertebral spaces between 1st and 2nd and 2nd and 3rd l. vertebrae.
Intestinal reflex of dilatation.	11th d. vertebra.
Splenic reflex of contraction.	1st, 2nd and 3rd l. vertebrae or intervertebral spaces between the 1st and 2nd and 2nd and 3rd l. vertebrae.
Splenic reflex of dilatation.	11th d. vertebra.
Uterine reflex of contraction.	1st, 2nd and 3rd l. vertebrae or corresponding intervertebral spaces.

Bladder reflex of contraction.	5th l. vertebra.
Kidney reflex of contraction.	12th d. or 7th c. vertebra.
Kidney reflex of dilatation.	6th, 7th and 8th d. vertebrae or intervertebral spaces between the 6th and 7th and 7th and 8th d. vertebrae or 10th d. spine.
Vaso-constrictor effects (?) reflexly.	7th c. vertebra.
Vaso-dilator effects (?) reflexly.	9th, 10th, 11th, 12th vertebrae or the corresponding intervertebral spaces.

A study of the reflexes associated with pathological conditions with a view to meeting therapeutic indications is important. Their use in the treatment of disease will be considered later in the study of the diseases for which vibratory treatment is employed.

In a study of the spine pathologically, the following will be found of value.

"*Disease.**	*Onset.*	*Disease.*
	Sudden (few minutes)	Vascular lesions.
	Acute (few hours or days)	Vascular lesions. / Inflammation.
Pressure and growths.	*Subacute* (one to six weeks)	Inflammation.
Pressure and growths.	*Subchronic* (six weeks to six months)	Inflammation. / Degeneration."
Pressure and growths.	*Chronic* (more than six months)	Degeneration."

If inflammation of the bones of the spine is present it causes spasmodic restriction when the body is moved. When the *ligaments of the spine are inflamed* there may be no motion as anchylosis may occur "with or without alteration of the physiological curves."

Spinal pain is frequent in meningitis and meningeal growths. In organic disease of the vertebral

* Gowers. Diseases of the Nervous System, page 279. Vol. 1.

bones it is almost a constant symptom. Concussion of the spine causes local pain and tenderness more often through a considerable extent of the vertebral column, or has more than one place of chief intensity and tenderness. On the other hand, pain due to organic affections of the cord is more usually referred to the neighborhood of the spine, as to the loins or the sacrum, than to the spinal column itself.

Gowers calls the pains that are referred to the parts to which the sensory nerves are distributed "excentric" or "radiating pains," and he divides them into two classes.

"1. Those due to the irritation of the posterior nerve roots in their passage through the intervertebral foramina, through the membranes, or through the posterior columns of the cord," which he calls "root pains." They are often intense and "correspond in level to the disease."

"2. Those produced by irritation of the sensory conducting tracts," which may be acute, particularly so, if the lesions affect the "conducting tracts by pressure," but oftener they are dull in character resembling rheumatic pains.

" A third class of pains,—resembling root pains,—depend on degenerative changes in the nerve-fibres; the molecular alterations that result give rise to upward impulses of considerable intensity." These occur in locomotor ataxia, etc. They may be dull or acute and may be "in the root-fibres" or in the peripheral nerves. Root pains are most severe in vertebral bone disease and have "the characteristic that they are increased by movement, and in growths commencing in the bones (which are usually

malignant). This feature is of considerable diagnostic importance." Gowers states that in carcinoma the pain is "frequently referred to the neighborhood of the column, while in caries it seems more frequently to affect the side of the chest." Sometimes pain is referred to anesthetic surfaces as in vertebral disease, spinal caries, or tumors, when it results in anaesthesia dolorosa* due to the destruction of the sensory nerves causing surface anaesthesia, and to irritation of the proximal ends of the destroyed nerves resulting in painful sensations which are sent inward to the cord and referred to the anaesthetic surface.

Starr also notes that in spinal cord disease as locomotor ataxia where the posterior nerve roots "at their entrance" or "the sensory tracts passing upward through the spinal cord" are affected, "pain is not referred to the back but is felt in the part of the body from which the irritated nerve root or sensory tract has come." He cites the following to illustrate. Locomotor ataxia generally commences in the second and third lumbar segments of the cord so the pains are usually referred to the anterior surface of the thighs. When the fourth and fifth lumbar segments are attacked the pain is referred to the feet. When the dorsal region is invaded body pain results and when the lower cervical is affected the pain is referred to the axilla, the inner side of the arms and to the little fingers, and when the upper cervical segments are affected "by the sclerotic process, the entire arms and shoulders become the seat of pain." Peripheral pain corresponding to the affected segment of the cord also occurs in syringomye-

* Starr. Organic Nervous Diseases, page 197.

lia. Injuries to the cord, hemorrhages within the cord, spinal dislocations or fractures cause peripheral pain.

In the hypertrophic type of osteo-arthritis, when the dorso-lumbar part is affected, referred pain is unilateral or bilateral as in the foot or leg; if the cervical portion is affected the referred pain is unilateral in the hand and arm, and atrophy is found on the affected side. Goldthwait, Painter and Osgood* noted an important diagnostic point between this disease and true neuritis in that "there is no tenderness along the nerve trunks" as in neuritis when pressure on the trunk causes pain in the periphery. "Strains and injuries may affect the lumbo-sacral cord when pain and anaesthesia or hyperaesthesia are referred to parts supplied by the nerve affected, generally to the back of the thigh and lower leg." Movement of the body resulting in pressure, may cause "sharp, shooting pains felt in any part of the body below the lesion."

Pelvic headaches according to Garrigues† may cause pain "(1) at 4th and 5th lumbar vertebrae, the spinal-center for the internal pelvic organs, or (2) on either side of the 2nd sacral vertebra due to a cellulitis of the utero-sacral ligaments." Pain‡ from the sacrum to the 3rd dorsal vertebra without limitation of spinal movement will indicate that the lumbo-dorsalis fascia is affected.

Tumors of the cord cause pain "referred to the periphery from which the nerve root comes, which is primarily compressed at the site of the tumor." The parts below the site of the growth may be pain-

* Diseases of the Bones and Joints, pages 332 and 333.

† Abrams. Spondylotherapy, page 89.

‡ Abrams. Spondylotherapy, page 99.

ful owing to irritation of the sensory tracts passing through the cord at the site of the tumor."

Lesions of the back such as trauma, sprains, etc., of spinal ligaments, vertebral fracture or displacements. any cause of compression, "concussion of the cord, tumors, neurasthenia, nephritis, cystitis, calculi,—renal, biliary, or vesical,—visceral affections, hysteria, myelitis and spinal diseases above mentioned should be considered in a study of pain in the back.

Following its elicitation by mechanical vibration, the ball vibratode being used for spinal administrations and the disc for surface work, the interpretation of pain or tenderness is important. The following is from Cyriax's, Schmidt's, Butler's, and the author's observations, and refers mostly to tenderness. For further details with reference to pain, the reader is referred to Schmidt's "Pain," Butler's "Diagnostics of Internal Medicine," and Cyriax's "Elements of Kellgren's Manual Treatment."

HEAD AND SCALP

Tenderness of scalp.	Cervico-occipital neuraligia, hysteria, syphilitic periostitis, hemicrania.
Hypertension headache.	Constipation or causes of high tension. Erythromelalgia. Pelvic inflammatory conditions. Eye strain or affections. Ear and nasal disturbances. Alimentary tract disorders.

NECK

"Tenderness.	"Enlarged lymphatic glands, cervico-occipital neuralgia, cervical myalgia, cervical caries," brachial neuritis usually, myositis, rheumatoid arthritis, and spondylitis deformans, tonsillitis (Snow).

Tenderness due to vascular spasm in head.	Erythromelalgia (Snow).

SHOULDER

"Spontaneous shoulder pain. Tenderness of brachial plexus. Tenderness at junction of outer and middle thirds of upper border of trapezius.	Lung—Disease of pulmonary apices as tuberculosis and new growths.
"Persistent shoulder pain bilateral or unilateral. Tenderness over brachial plexus frequently and in upper intercostal space in front. Diagnostic value—Pain increased by exertion. Lifting arm from side above the horizontal line usually causes pain.	Thoracic aorta—aneurysm and atheroma.
"Shoulder pain and tenderness of brachial plexus. Tenderness at edge of trapezius.	Subdiaphragmatic organs. Inflammatory processes in liver, spleen, stomach or in their subphrenic surroundings."
Shoulder pain at upper part.	Bursitis.
Shoulder pain posteriorly, anteriorly, and superiorly.	Brachial neuritis and rheumatoid arthritis (Snow).

THORAX

"Tenderness in front.	Ostitis or periostitis of sternum or ribs, or inflammation of costal cartilages.
Tender breast.	Hysteria or tumor," or pelvic conditions as menstruation (Snow).
Tender points.	Intercostal neuralgia, projecting or eroding aneurysm, abscess of chest wall, and perforating emphysema.
Tender infraclavicular spaces.	Advanced phthisis.
Pressure on precordial region causing pain.	Pericarditis."
"Tenderness of sternum and of the left dorsal region with sternal pain and retrosternal pain.	Oesophageal stretching with stenoses of lower part."

Scapular and Interscapular Region

"Scapular and interscapular tenderness.	Disease of the spinal column. Disease of the dorsal muscles." Brachial neuritis (Snow). "Pulmonary affections: Chronic inflammatory changes of pleura causing adhesions or glandular changes. Secondary neuralgic conditions of intercostal nerves. Rheumatoid arthritis when shoulder or arms affected (Snow).
Pain especially on left side (interscapular region).	Aortic lesions (aneurysm), chronic aortitis.
Related to left shoulder blade.	Spleen and stomach." Brachial neuritis of left brachial plexus (Snow).
Related to right shoulder blade.	Liver and gall bladder (Snow). Brachial neuritis of right brachial plexus (Snow).
"Related to left shoulder blade or both.	Stenosis of pylorus."
Under right shoulder blade.	Spasmodic contraction of pylorus (Snow).
"Pain in interscapular space.	Headache with increase in intracranial pressure."

Epigastrium

Tenderness.	Fatigue of origins of recti caused by coughing.
"a. *Below the right costal arch.* Spontaneous pain and tenderness.	Tender gall bladder in cholelithiasis, tender pylorus, duodenum (ulcer), the hepatic flexure of the colon as in carcinoma or flatulence. Renal infarct." In appendicitis although the pain is usually lower (Snow).
"Usually only tenderness.	Pleurisy and pneumonia of lower lobe.

b. *Below the left costal arch.* Spontaneous pain and tenderness.	Ulcerative conditions of stomach. Intestinal carcinoma (pain radiates to anus if descending colon). Flatulency. Pancreatic lesions (cysts). Painful cardiac conditions (angina pectoris).

ABDOMEN

"General tenderness.	Dysentery, dysmenorrhea, strangulated hernia, cancer of intestine, hysteria, ulceration of intestine, peritonitis, diaphragmatic pleuritis, irritant poisons," flatulency, colitis (Snow).
Tenderness over lower part of abdomen extending to either side.	Disease of uterus, tubes or ovaries. Exudates in the cul de sac of Douglas. Cystitis, hernia. (Make a rectal and vaginal examination).
Tenderness on left side.	Ovarian disease, salpingitis, pyosalpinx, neuralgia, or inflammation, adhesions due to tumors," impaction in sigmoid, or colitis (Snow). "Membranous enteritis or pelvic peritonitis."
Tenderness on right side.	Appendicitis, salpingitis, pyosalpinx, ovaritis (Snow).

BACK

"Tenderness the length of spine—"continuous or in a series of points."	"Periostitis (spinal). Spinal irritation. Spinal meningitis." Rheumatoid arthritis (Snow). "Cerebro-spinal meningitis. Hysteria. Myelitis." Pelvic and alimentary tract disturbances (Snow). Spondylitis deformans (Snow).
"Tenderness over dorsal spine.	Enlarged bronchial glands. Tumor in posterior mediastinum. Gall stones (Snow). Stomach disorders (Snow). Liver congestion (Snow). Herpes Zoster (Snow). "Thoracic aneurysm. Tuberculous disease of the spine."

Tenderness over 6, 7, 8, 9 dorsal vertebrae.	Coughs (Abrams).
"Tenderness over lumbar spine.	"Abdominal aneurysm. Subphrenic abscess. Suppurative and acute nephritis. Lumbar abscess. Tuberculous disease of spine." Lumbo-sacral cord disease (Snow).

Lumbar Region, Unilateral and the Flanks

"Spontaneous pain or tenderness, or only tenderness by pressure.

On right side.	Appendicitis with retro-caecal abscess. Hepatalgia. Cholelithiasis." Contraction of quadratus lumborum in asthma (Snow).
"On left side.	Gastric ulcer. Perisplenitis. Pancreatic lesions.
"On either side especially if corresponding flank is tender.	Renal affections."
Tenderness in flanks (Snow).	Prostatitis. Fibroid tumor. Uterine affections. Goldthwait's disease. Sacro-lumbar cord involvement. Neuritis or sciatica.

Atypical Abdominal Tenderness or Pain

"a. Attacks of colic or pain. Look for attendant symptoms, and points of maximum tenderness.	Appendicitis and gall bladder lesions may cause pain in wall of epigastrium. Biliary colic, ureteral colic, and pancreatic disease may cause pain over large area. Testicle.
"Spontaneous pain with tenderness.	Pathological processes in abdominal lymph glands, mesenteric and retroperitoneal as in typhoid, tuberculosis, neoplastic mesenteric glands.

"Pressure neuralgia.	Swollen glands. Tubal pregnancy.
Intestinal colic.	Portal obstruction. Tapeworm. Foreign bodies as fish bone. Intestinal stenoses, hernias, etc.
Visceral neuralgias due to the nerve supply of the organ or its vascular system.	Spinal diseases as tabes. Organs themselves. Involvement of abdominal sympathetic and its branches. Functional disorders like vascular spasm. Circulatory disorders as portal obstruction.
Pain in corresponding organ.	Changes in vascular supply of organ as dilatation, constriction, occlusion, embolism and thrombosis."
"Flatulent colic.	Portal obstruction with meteorism or a secondary nephrolithiasis due to sedimentation of urine in renal pelvis of a congested kidney, or gastric ulcer or cholelithiasis."
Local tenderness just below the ribs on a line extending toward the umbilicus and sometimes toward the appendix.	Gall-stones (Snow).
"Local tenderness.	Foreign bodies impacted in intestine. Accumulation of gas found in neuropathic constitution, enteroptosis and tobacco heart."

SACRAL REGION (SNOW)

Tenderness over sacro-iliac-joint.	Goldthwait's disease.
Tenderness in hip.	Neuritis. Sciatica. Pelvic adhesions.
Tenderness in both hips.	Rheumatoid arthritis. Neuritis—involvement of lumbosacral cord. Phlebitis. Prostatitis. Uterine affections as fibroid tumors.

JOINTS

Tenderness in joints.	Arthritis—simple, rheumatoid, osteo—and of Still's disease. Synovitis. Sprain. Gout. Tuberculosis. Traumatic infection. Rheumatism. Gonorrhea. Blood diseases—haemophilia, scurvy, arthritic forms of purpura (Butler). Nervous diseases—chorea, hysteria, acute myelitis (Butler).
Tenderness in extremities.	Neuritis—tenderness in muscles associated with tender joints. Sciatica. Phlebitis. Ostitis or periostitis (Butler). Rachitis, scurvy, trichinosis, or tetanus (Butler). Diseased teeth may cause pain in heel (Snow). Erythromelalgia.

NERVE TENDERNESS*

Pathological states of.	*Associated with tenderness.*	*Exit of nerve* (Snow).
Lungs and bronchi.	Between scapula (2nd to 4th thoracic sympathetic ganglion largely from the posterior pulmonary plexus.	Between 2nd and 3rd, 3rd and 4th, 4th and 5th d. vertebrae.
Heart.	4th and 5th d. nerves of left side.	Between 4th and 5th, and 5th and 6th d. vertebrae.
Liver and gall bladder.	6th and 7th d. nerves of right side (below and internal to inferior angle of right scapula).	Between 6th and 7th, and 7th and 8th d. vertebrae.
Stomach.	6th, 7th and 8th d. nerves left.	Between 6th and 7th, 7th and 8th, and 8th and 9th d. vertebrae.

* Cyriax. Elements of Kellgren's Manual Treatment.

Pylorus.	6th, 7th and 8th d. nerves right.	Between 6th and 7th, 7th and 8th, and 8th and 9th d. vertebrae.
Intestine.	6th to 11th d. nerves.	Between 6th and 7th, 7th and 8th, and 8th and 9th, and 9th and 10th d. vertebrae.
Diaphragm.	2nd sometimes 1st l. nerve.	Between 2nd and 3rd l. vertebrae and sometimes between 1st and 2nd l. vertebrae.
Spleen.	9th and 10th d. nerves.	Between 9th and 10th and 10th and 11th d. vertebrae.
Kidneys.	10th, 11th, 12th d. nerves.	Between 10th and 11th, 11th and 12th and 12th d. and 1st l. vertebrae.
Genital organs.	12th d., 5th l., 2nd to 4th sacral nerves.	Between 12th dorsal and 1st l., 2nd to 4th sacral foramina.
Uterus.	3rd s.	3rd s. foramen.
Rectum.	4th s.	4th s. foramen.
Bladder.	Sacral nerves especially 1st and 3rd sacral.	Sacral foramina especially 1st and 3rd sacral foramina.

Reed* in explaining the word "autonomic" as applied to the manifestations of pain of visceral origin states that it includes three factors:

"1. Some more or less profound disturbances, functional or organic, of certain of the viscera.

"2. The transmission of a painful impulse, thus originated, over or through what Head has designated as the autonomic nervous system.

"3. The registration of that impulse and its expression as pain in the muscle or muscles to which the respective external or peripheral autonomic filaments (muscle nerves) are distributed."

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* Reed. The Autonomic Manifestation and Peripheral Control of Pain Originating in the Uterus and Adnexa. *The Journal of the American Medical Association,* March 25, 1911.

The conclusions of the same author are interesting as they are fully in accord with Dr. Wm. Benham Snow's and the author's observations during the past eight years.

"1. Visceral pain, although due to pressure, when the abdomen, pelvis and thorax are concerned, is expressed chiefly but not exclusively in the autonomic algetic areas of the protective walls covering the respective viscera, such algetic areas corresponding in extent with the peripheral distributions of the autonomic nerves coincidently with the peripheral distribution of the respective spinal nerves in the muscles and subserous connective tissue.

"2. These distributions can generally be determined clinically by determining the area of partial hyperalgesia.

"3. The pain itself, consisting chiefly of hyperexcitation of muscle irritability, can be partially and, as a rule, entirely, inhibited by inhibiting the muscle sensibility in the hyperalgetic areas."

When examining an organ with a vibrator, interrupted vibration with varying degrees of pressure limited to the patient's tolerance is used, the disc applicator being always employed. A sensitive gall bladder, pylorus, congested liver, kidney or spleen, painful stomach or colonic flexures, appendix or ovary are all revealed by applied mechanical vibration. Painful sites, anteriorly on the chest or posteriorly in the upper portion of the back along and near the spine, are elicited in cases of asthma. A clue to gastric trouble is given when spinal vibration causes eructation of gas. Vibration localizes the pain, or demonstrates the presence of unsuspected hyperalgesia. It must be recalled that pain

is influenced by "position, motion, pressure, food, drugs, chemicals and organic function."

When an examination of an organ or area is undertaken, we should remember "the cutaneous expression of visceral disease" as discovered by Head. These sensitive areas on the surface "correspond to spinal segments from which the posterior roots take their origin, and not to their peripheral distribution." "When a stimulus is applied* to an organ or tissue with diminished sensibility and which is centrally connected with an organ or tissue with a higher degree of sensibility, pain is referred to the organ or tissue which is relatively more sensible." It is of interest to note in connection with sensory phenomena† that "all the nerves including the 5th and glosso-pharyngeus, lost their *reflex* influence after the pituitary body had been removed."

THE MUSCLES SHOULD BE EXAMINED for tension and response, and the operator should note whether it is local or reflex or whether the vibration induces reflex contraction or pain in distant parts. Rigidity of the back muscles if related to diseases of the spine prohibits all motion. Interrupted vibration with the disc vibratode is employed in the examination of muscles, although spinal vibration is applied with the ball over the vertebra for testing the muscular reflexes.

Gowers‡ states that in connection with the spinal cord a spasm caused by reflex action is usually produced in the legs and trunk; "the flexor spasm seems to be due to an over action of the centers for

* Abrams. Spondylotherapy, page 59.

† Sajous. The Internal Secretion and the Principles of Medicine, page 999.

‡ Ibid. Diseases of the Nervous System, page 256.

cutaneous reflex action, the extensor spasm chiefly to that of the centers for muscle reflex action" although a cutaneous impression might excite it indirectly.

The following is an example of *reflex spasm.* Miss M. complained of contractions in the vicinity of the stomach which incapacitated her for work. They were spasmodic and increasing in frequency. An examination revealed tension in some muscles of the back, to the left of the spinal column the spinal nerve supply of which through the sympathetics caused spasmodic contractions anteriorly. Inquiry elicited the fact that she had strained herself when lifting a heavy patient which had resulted in a tonic muscular spasm of the back and reflex clonic spasms over the stomach, causing her great discomfort.

The relation of tension to disease inducing muscular spasm, either directly or reflexly, tonic or clonic, is a subject yet undeveloped, but demands thought and investigation. Usually every peripheral spasmodic condition has an associated muscular spasm also in the corresponding spinal region. This spinal spasm is often overlooked. Care and practice in regulating the pressure when applying spinal vibration will elicit information that is hidden from the novice. An expert diagnostician sees with his fingers; so must an expert operator with the vibrator make his vibrator find obscure conditions.

When examining a stiff hand, interrupted vibration with the disc vibratode is employed over the affected muscles of the forearm at their origin at the elbow joint, and over the forearm, wrist and hand. When the hand is to be vibrated the patient should

be directed to clench his fist as far as possible, interrupted vibration is then applied just above and below each row of joints making pressure to assist in closing the hand as the muscles relax under vibratory treatment. To test the flexibility of the hand, the operator with his hand placed directly over the patient's hand, finger for finger, slowly closes the patient's hand while the patient exhales. If the hand will nearly close after your treatment, the probability is that you can promise a complete cure.

Interrupted vibration with the disc vibratode over the pleura after PLEURISY will reveal sites of old adhesions.

COCCYGODYNIA is diagnosed during a general examination by eliciting pain on vibration over the coccyx.

In considering INTERCOSTAL NEURALGIA, CARDIAC DISEASE, ANGINA PECTORIS AND AORTIC DISEASE, Abrams, Head and Mackenzie* have formulated the following:

"In intercostal neuralgia the pain radiated to the neck and arm. In cardiac and aortic disease, the pain is referred along the 1st, 2nd, and 3rd dorsal nerves.

"In angina pectoris, the pain in addition may be referred from the 5th to the 9th dorsal nerves."

Intercostal neuralgia will elicit "the three tender points of Valleiz, viz.: posteriorly, near the dorsal vertebrae; laterally, in one, two, or three intercostal spaces; anteriorly, in one or two intercostal spaces near the sternum, most frequently on the left side."†

* Abrams. Spondylotherapy, page 194.

† Reference Handbook of the Medical Sciences, Vol. V., page 454.

The heart reflex of Abrams is of value in diagnosis as well as prognosis. It can be induced by vibration of the 7th cervical vertebra. My observations have coincided with those of that investigation. The strength of the heart is increased and under certain existing conditions it will lower blood pressure.* An induction of the heart reflex is favorable as to prognosis in cardiac insufficiency. When the sphymomanometer is used to take the pressure before and after treatment, the author has noted a fall of 15 mm. after a five-minute vibratory treatment followed by a second period of five minutes; using a low frequency of vibration.

Vibration assists in determining whether a high blood pressure is due to a feeble heart. A boy 12 years old who had been to various clinics for heart treatment and pronounced hopeless, came under observation with a blood pressure of 135 mm. Treatment by the vibrator, using the ball vibratode over rubber, over the 2nd and 3rd dorsal spines, gave no result whereas after vibration of the 7th cervical spine, the high pressure showed a fall of 12 mm., which according to Abrams, demonstrates that it was caused by cardiac weakness and the vibration of the spine in question reduced pressure "by toning the heart," vibration of fairly low frequency being used for two seances of five minutes with a slight intermission. The heart reflex elicited directly over the heart is a test of the strength or power of the myocardium.

Mechanical vibration should be used intelligently as a means to an end and not in an indifferent way. Diagnosis made by means of the vibrator may show

* Abrams. Spondylotherapy, page 248.

a condition in which vibratory treatment may or may not be indicated. Drug therapy, surgery, physical measures other than vibration, such as the static, galvanic or high frequency currents, light, hot air, radium or the X-ray may be required either singly or in combination with vibration to cure or relieve the conditions found.

CHAPTER VII

THE RELATION OF MECHANICAL VIBRATION TO THE HEART, BLOOD VESSELS, AND DUCTLESS GLANDS

PERCUSSION OF THE HEART yields dulness of two types—superficial and deep. (1) Superficial or absolute dulness is elicited by weak percussion only, representing "that portion of the heart not covered by lung tissue." A small part of the heart posterior to the sternum and uncovered by lung tissue yields a resonance because "the percussion blow is conveyed by the sternum to the adjacent lung structure." (2) Deep or relative dulness is elicited by strong percussion. The deep cardiac dulness, which concerns us in the study of the heart reflex of Abrams, "extends vertically from the 3rd rib and ends at the 6th, but owing to the cardiac merging in the hepatic dulness, this lower limit cannot be accurately ascertained, while transversely at the 4th rib it extends from just within the nipple line to slightly beyond the right of the sternum."

THE AREA OF CARDIAC DULNESS varies in pathological conditions, and as any change from the normal should be considered when studying the reflex action of the heart, a brief summary of such changes is here noted. In hypertrophy and dilatation it is increased from above to the left and downward when the left ventricle alone is involved. The dulness is "broader and increased toward the right side" when the right ventricle is involved. When there is hypertrophy of both ventricles "the apex beat is rounded and diffuse." In hydro-pericardium the outline of "pre-

cordial flatness is a blunt cone'' and different positions change the area. The presence of tumors, pleuritic effusions on the left side, retraction of the lung, or ''infiltration of lung adjacent to the heart'' may apparently increase the cardiac dulness when the heart is normal. Diminished area of dulness is found in atrophy of the heart, absorption of fat in wasting disease, emphysema of the lung and mediastinum, and pneumo-pericardium. For diagrammatic illustrations of heart dulness in disease the reader is referred to Butler's ''Diagnostics of Internal Medicine.''

A BRIEF REVIEW OF THE NERVOUS MECHANISM OF THE HEART is of value in the analysis of vibratory or concussional effects upon the heart. The heart's action* according to Howell, is under control of:

''1. Efferent nerve fibres from the central nervous system through the vagus nerves (inhibitory nerve fibres). Their stimulation slows or stops the heart beat.

''2. Efferent nerve fibres from the central nervous system through the sympathetics (accelerator or augmentor fibres). Their stimulation accelerates or increases the force of the heart beats.

''3. Afferent nerve fibres. Their stimulation pathologically may cause sensations of pain.''

The branches of the vagus† supplying the heart are:

''1. Cervical branches, except lowest on each side, as a rule join the sympathetic cardiac branches and lose their identity. The lowest cervical cardiac branch of left pneumogastric goes to the superior car-

* Howell. Text-Book of Physiology, page 561.

† Cunningham's Manual of Practical Anatomy, page 67.

diac plexus. The lowest cervical cardiac branch of right pneumogastric goes to right portion of deep cardiac plexus.

"2. Thoracic cardiac branches are from trunk of right pneumogastric and go to deep plexus.

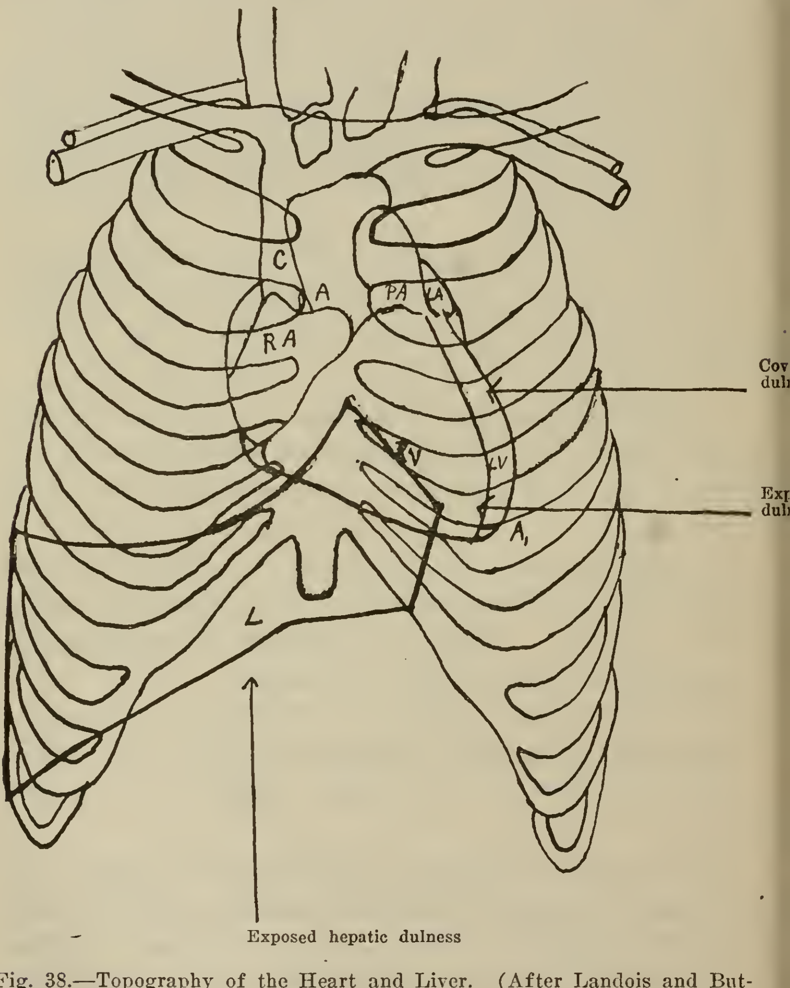

Fig. 38.—Topography of the Heart and Liver. (After Landois and Butler.) A, aorta; PA, pulmonary artery; C, superior vena cava; LA, left auricle; RA, right auricle; LV, left ventricle; RV, right ventricle; A_1, apex of heart; L, exposed portion of liver.

"3. Recurrent laryngeal branches of pneumogastric go to deep plexus."

The cardiac branches of the sympathetic are:

1. Upper sympathetic cardiac from upper cervical ganglion.

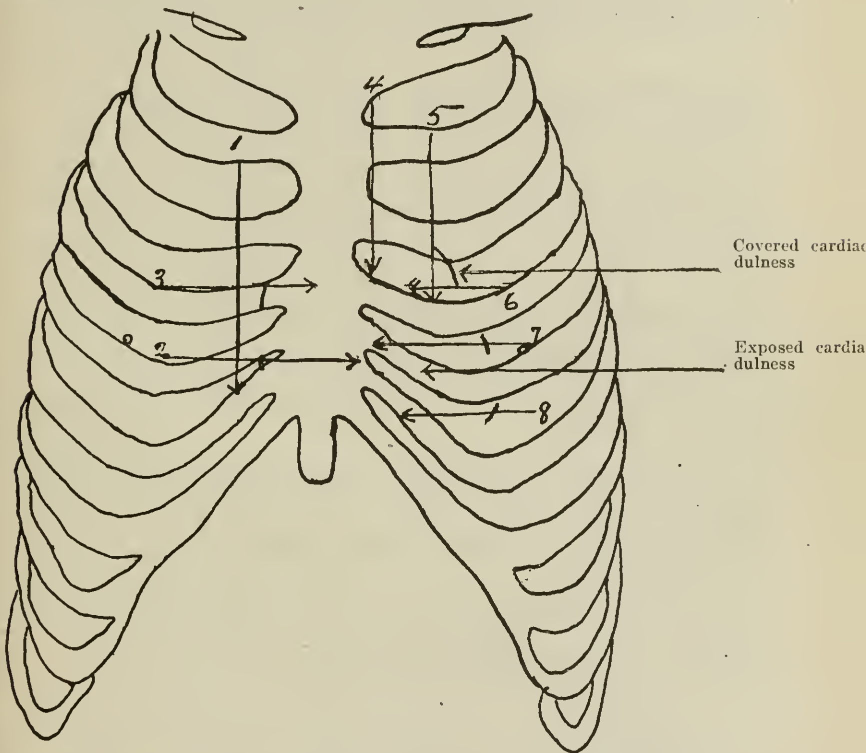

Fig. 39.—Percussion lines for ascertaining the area of cardiac dulness,—1, 2, 3, 4, 5, 6, 7, 8. (After Butler.)

2. Middle sympathetic cardiac from middle cervical ganglion.

3. Lower sympathetic cardiac from lower cervical ganglion.

The cardiac branches of the vagus and of the sympathetic form the cardiac plexus which are tabulated by Cunningham as follows:

a. ''*Superficial cardiac plexus.*	1. Superior cardiac branch of sympathetic of left side. 2. Lowest cervical cardiac branch of left pneumogastric.
b. ''*Left portion of deep cardiac plexus.* 1. It gives off a branch to left auricle. 2. A branch to left anterior pulmonary plexus. 3. To form left coronary plexus.	1. Middle and lower cardiac branches of sympathetic of left side. 2. Upper two cervical cardiac branches of pneumogastric. 3. Cardiac branches of the left recurrent laryngeal.
c. "*Right portion of deep cardiac plexus.* 1. It gives off a branch with filaments for right auricle. 2. A branch to right anterior pulmonary plexus. 3. To join superficial cardiac plexus and form right coronary plexus.	1. Three cardiac branches of sympathetic of right side. 2. Cervical cardiac branches of right pneumogastric. 3. Thoracic cardiac branches of the right pneumogastric. 4. Cardiac branches of the right recurrent laryngeal.

The influences of the cardiac nerves have been summarized by Engelmann* as follows:

''1. The chronotropic influence, affecting the rate of contraction.

a. Positive chronotropic actions causing an acceleration of the rate.

b. Negative chronotropic actions causing a slowing of the rate.

''2. The bathmotropic influence, affecting the irritability of the muscular tissue.

a. Positive.

b. Negative.

''3. The dromotropic influence affecting the conductivity of the tissue.

a. Positive.

b. Negative.

''4. The inotropic influence affecting the force or energy of the contractions.

a. Positive.

b. Negative.

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* Howell. Text-Book of Physiology, page 565.

The IRRITABILITY OF THE HEART is of concern to the student of vibration.

Landois states that:*

1. A weak stimulus alone not of sufficient strength to affect the heart when repeated may affect the heart as "the heart is capable of summation of individual stimuli."

2. A stimulus (even the feeblest) that will excite a contraction has "a maximal effect." (Bowditch, Kronecker and Stirling).

THE MAGNITUDE of the heart's beat depends not on the magnitude of the stimulus, but on the condition of the ventricle (or the heart).† This probably explains why one operator might obtain no result from vibration and another operator would get results, the element of strength and the number of stimuli being important.

THE CARDIO-INHIBITORY CENTER can be stimulated reflexly‡ by stimulating sensory nerves; or the central end of one vagus, if other intact, or by stimulating the sensory nerves of the intestines, which "arrests the heart's action," as proved by the tapping experiment of Goltz. Stimulation of the cervical sympathetic, the abdominal sympathetic or the splanchnic nerve directly (Asp and Ludwig) produces the same effect. "Very strong stimulation of the sensory nerves, however, arrests the above named reflex effect upon the vagus. The action of the heart may be arrested by stimulation of the vagus, not only by means of electrical stimuli but also by chemical (common salt, glycerine), or

* Landois. Text-Book of Human Physiology, page 115.

† Foster. Text-Book of Physiology, page 303.

‡ Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 849.

by mechanical stimuli. As a rule, the right vagus is more powerful than the left." The vagus lies under the sterno-mastoid between the internal jugular vein and the internal and common carotid arteries. Cyriax* has the patient bend "the head forwards or sideways" and by passing the finger "in front of the muscle or behind it" and giving friction "transversely across the nerve, cardio-retardation or eructations or even vomiting may result." If mechanical vibration is used in the same manner the soft cup-shaped vibratode is to be preferred. The automatic rhythm of the heart, the force of its contraction, and the power of conduction ("the capacity for conducting muscular contractions") are influenced by stimulation of the vagus. Abdominal vibration with the disc vibratode and cap shield has been found by the author to lessen the pulse rate. "The inhibitory neural cells for the heart are located in the nuclei of the 10th and 11th cranial nerves and their paths to the heart are through the 10th nerve." (Arnold.)

A rhythmical interrupted stimulus of a frequency of eighteen to thirty per second is necessary to produce cardiac inhibition.

Sajous'† recent conclusions relative to the heart, are as follows:

"*Inhibition* is a morbid process due to excessive vasomotor contraction of the coronaries causing a reduction in the quantity of blood supplied to the heart walls.

"1. No cardiac inhibitory apparatus exists as a physiological entity.

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* Cyriax. The Elements of Kellgren's Manual Treatment, page 159.

† Sajous. The Internal Secretions and the Principles of Medicine, page 452.

"2. Active inhibition of the heart may be caused by excessive stimulation of the vagus." Abrams considers that the best site for exciting the vagus is "the region of the spine in juxtaposition to the vertebral exits of the upper spinal nerves (at about the spinous process of the 4th dorsal vertebra)."

The writer has demonstrated that if the ball vibratode be applied on each side of the spine alternately between the transverse processes of the 7th cervical and 1st dorsal or 2nd and 3rd or 3rd and 4th dorsal vertebrae for five minutes the pulse rate will often be lowered.

THE RELATION OF THE HEART BEAT TO THE PRESSURE is thus stated by Foster.* " 'The rate of the beat is in inverse ratio to the arterial pressure,' a rise of pressure being accompanied by a diminution, and a fall of pressure by an increase of the rate of the rhythm. This, however, only holds good if the vagus nerves be intact." This is opposite to what we would naturally expect; for a high blood pressure means an increased resistance to the ventricular systole and a larger quantity of blood flowing through the coronary arteries, and naturally with a resulting increase in the heart's action, we would expect an increase "in the rate of rhythm as well as in the force of the individual beats."*

In one instance the pulse rate was lowered by the writer from 87 to 69 with a five-minute vibratory treatment, and the pressure was lowered at the same time 4 mm. which does not conform to Foster's law. The writer has also noted a lowering of both pulse and arterial tension from intervertebral vibration between the 2nd and 3rd dorsal vertebrae. The following case is illustrative.

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* Foster. Text-Book of Physiology, page 323.

Miss S.	November	3rd, before	treatment,	tension	152	mm.,	pulse 70
	"	" after	"	"	144	"	" 66
	"	4th, before	"	"	144	"	" 80
	"	" after	"	"	140	"	" 74
	"	5th, before	"	"	142	"	" 78
	"	" after	"	"	138	"	" 67

The arterial tension was reduced by the writer in one case from 188 to 180 mm., and the pulse rate from 96 to 90 by intervertebral vibration between the 7th cervical and the 1st dorsal vertebrae.

Cyriax cites a case where accompanying other conditions there was irregular heart action, the "whole body shook, and every third or fourth beat was missed," with a systolic murmur in the mitral area. Pulse was 130 per minute. "Heart vibration (manual) and shaking with frictions on the left 4th and 5th dorsal nerves near the spine, together with stomach exercise, caused the "intermittency and irregularity to almost disappear" and the pulse fell to 108. Sleep followed. The symptoms returned the next morning. The same treatment relieved the heart condition and the pulse fell to 100. Sleep followed. On awakening the heart was better—more regular, and the intermittencies and the murmur had disappeared. The pulse was 112. Treatments were continued twice daily for the next two days, when the "heart was quite normal beyond slight acceleration of pulse."

Landois* states that the vagus can be stimulated mechanically occasionally by digital "compression against the cervical portion of the vertebral column, but alarming attacks of syncope have been observed to follow this procedure." Arterial tension was also reduced in another case by the author from 120 to

* Landois. Text-Book of Human Physiology, 4th ed., page 759.

112 mm. and the pulse rate from 86 to 80. Apparently the vagus was affected or "efferent nerve fibers from the cerebral nervous system through the vagus" or the adrenals were affected. There at least resulted a "reduction of the vagal vibratory rhythm" causing a lower number of heart beats per minute. Butler believes that "a decreased pulse rate may be due to pneumo-gastric irritation or paralysis of the cardiac sympathetic nerves and ganglia."

"3. *Passive inhibition* of the heart is primarily due to *insufficiency of the adrenals.*"

The reasons for this are embodied in the following general summary of the functional mechanism of the heart:

"1. The nervous supply of the heart is derived from the general motor (sympathetic) and vagus systems.

"2. The general motor plexuses and nerves maintain the normal tonic contraction of the coronaries and other cardiac vessels and insure distribution of the blood among the muscular elements.

"3. The vagal plexuses and nerves incite and govern the rhythm of the heart, reducing or increasing its beats.

"4. Increase of the vagal vibratory rhythm (impulses) causes quickening of the heart-beats.

"5. Excessive vibratory rhythm of the vagus (or spinal accessory) causes arrest of the heart-beats: i.e., inhibition."

"Foster believes* that spinal accessory nerve fibres pass from the bulb to become a part of the vagus trunk in the dog and that these spinal accessory fibres supply the inhibitory fibres to the heart." The

* Foster. Text-Book of Physiology, page 313.

spinal accessory nerve can be reached "at about the middle of the posterior border of the sterno-mastoid" or "at a point in the trapezius in a line drawn directly backwards from the middle of the clavicle." (Cyriax.)

"6. Reduction of the vagal vibratory rhythm causes, when physiological, slowing of the heart-beats.

"7. Reduction of the vagal vibratory rhythm, when pathological, especially when due to adrenal insufficiency, results in quickening and weakening of the heart-beats, through loss of vagal control.

"8. Cessation of the vagal vibratory rhythm (as after division of the vagus on both sides) is followed by marked quickening and weakening of the heart-beats, through loss of vagal control.

The preceding summary gives a physiological working basis for vibratory research work in connection with the treatment of certain cardio-vascular derangements both functional and organic.

Kirke states that in a frog the heart's condition, site of stimulation and intensity of stimulus applied to the vagus determine the resulting effects, inhibition or increased activity. Varying results are obtained* depending upon whether "we stimulate (1) the vagus in the cranium before it is joined by the sympathetic, (2) the sympathetic fibres before they join the vagus, (3) the vagus trunk containing both the real vagus and the sympathetic fibres. A very prolonged inhibition† may be produced by prolonged stimulation. The total effect of stimulating the vagus fibres is not to exhaust the heart, but rather to

* Foster. Text-Book of Physiology, page 308.

† Foster. Text-Book of Physiology, page 309.

strengthen it; and by repeated inhibitions carefully administered, a feebly beating heart may be nursed into vigorous activity." It is under such conditions that a person who has fainted can be revived by spinal concussion of the 7th cervical vertebra or by intervertebral vibration between the 7th cervical and the 1st dorsal vertebrae.

ACCELERATION OF THE HEART BEAT or strengthening of the contraction of the heart (Heidenhain and Löwit) or the latter effect only may be induced by stimulation of certain accelerating fibres in the cervical sympathetic. (Pawlow.)

Foster* says that stimulation of the augmentor fibres sometimes "increases the rapidity of the rhythm," which increase may be conspicuous or slight, and yet "a more constant and striking effect is the increase in the force of the beat. The output of the heart is increased, which may occur in spite of a concomitant rise of arterial pressure so that the effect of the action of the augmentor nerves is distinctly to increase the work of the heart, and this may take place even though no marked acceleration occurs." These facts should be considered when employing mechanical vibration.

THE ACCELERATOR CENTER is believed by Howell† to be in the brain. He says, that "since stimulation of the upper cervical region of the cord causes acceleration it seems evident that the paths must begin somewhere in the brain." The accelerating‡ set of neurons for the heart come principally "from the sixth cervical to the first or second dorsal segments."

* Foster. Text-Book of Physiology, page 317.

† Howell. Text-Book of Physiology, page 575.

‡ Arnold. The Importance of the Physical Examination of the Back in General Diagnosis. *Medical News,* March 18, 1905.

Experimentally the accelerators are stimulated* in branches communicating with the inferior cervical ganglion, or the stellate, the first thoracic ganglion, is stimulated.

The inferior cervical ganglion may be vibrated by applying the vibratode on the head of the first rib, the head articulating with the body of the 1st dorsal vertebra, on each side of the spine. It communicates with the 7th and 8th cervical (Krause says 8th cervical and 1st dorsal) spinal nerves whose exits are reached between the transverse processes of the 6th and 7th cervical, and the 7th cervical and 1st dorsal vertebrae. Anteriorly the inferior cervical ganglion is "behind the clavicular insertion of the sternomastoid."

The sympathetic† was stimulated in the neck, at Sy. Fig. 40 the nerve being cut below so impulses could only "pass up to the vagus and then down the mixed vagus trunk to the heart.† The beat of the heart was augmented." The beats increased in frequency or force or most generally in both. "A heart which has almost ceased to beat by proper stimulation of the sympathetic may be called back into vigorous activity." Sajous‡ says, "that we are here dealing with stimulation of the adrenals, seems probable. The anterior pituitary body becomes activated under these circumstances, through the carotid plexus." Not only is the vagus stimulated, but the suprarenal glands are stimulated, which Sajous says represents "the most effective means to bring about

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* Howell. Text-Book of Physiology, page 573.

† Foster. Text-Book of Physiology, page 309.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 446.

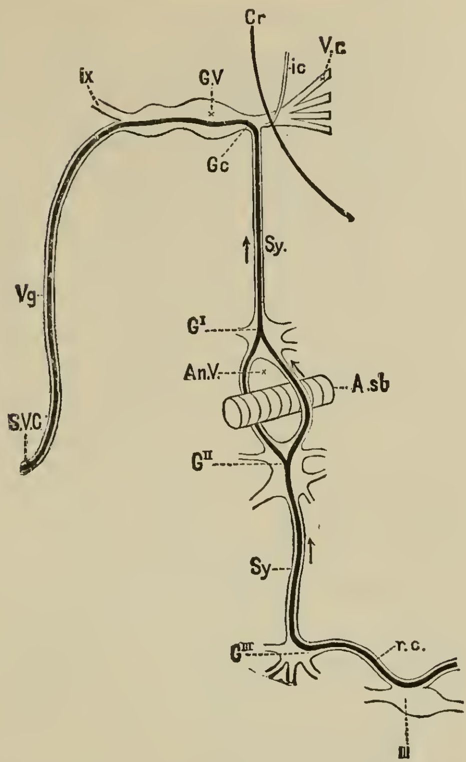

Fig. 40.—Diagrammatic Representation of the Course of Cardiac Augmentor Fibres in the Frog. (Foster's Text Book of Physiology, Macmillan & Co.) Vr., roots of vagus (and IXth) nerve. GV., Ganglion of same. Cr., line of cranial wall. Vg., Vagus trunk. ix. ninth, glossopharyngeal nerve. S. V. C., superior vena cava. Sy., sympathetic nerve in neck. G. C., junction of sympathetic ganglion with vagus ganglion, sending i. c. intracranial fibres passing to Gasserian ganglion. The rest of the fibres pass along the vagus trunk. G′, sympathetic ganglion connected with the first spinal nerve. G″, sympathetic ganglion of the second spinal nerve. An. V., annulus of Vieussens. A. sb., subclavian artery. G‴, sympathetic ganglion of the third spinal nerve. III., third spinal nerve. r. c., ramus communicans.

The course of the augmentor fibres is shown by the thick black line. They may be traced from the spinal cord by the anterior root of the third spinal nerve, through the ramus communicans to the corresponding sympathetic ganglion G‴ and thence by the second ganglion G″, the annulus of Vieussens, and the first ganglion G′ to the cervical sympathetic Sy, and so by the vagus trunk to the superior vena cava S. V. C.

the effects witnessed." "This is affirmed by Foster who says that 'the augmentation resulting from the stimulation of the sympathetic is followed by a period of reaction in which the beats are feebler, in other words *augmentation is followed by exhaustion* and indeed by repeated stimulation of these sympathetic fibres, a fairly vigorous heart, especially a bloodless one, may be reduced to a very feeble condition.' " Sajous believes that the vagus incites and governs the active stage of the functional processes of the heart and other organs supplied by it. He also believes that: stimulation of augmentor fibres affects first the adrenals and secondly the vagus. Foster* " traces augmentor fibres in a frog from the spinal cord by the anterior root of the third spinal nerve through the ramus communicans to the corresponding sympathetic ganglion G‴ and thence by the second ganglion G″, the annulus of Vieussens, and the first ganglion G′ to the cervical sympathetic Sy and so by the vagus trunk to the superior vena cava." The course of the augmentor and inhibitory fibres in a dog is represented in Fig. 41.

The same authority† says that stimulation of these several cardiac nerves has shown the presence of augmentor fibres "in some or other of the nerves passing from the lower cervical ganglion (middle cervical ganglion?) and the adjoining vagus trunk from the annulus of Vieussens, especially the lower ventral limb, and sometimes from the stellate ganglion itself (receiving branches from the 1st, 2nd, and 3rd thoracic spinal nerves and from the 7th and 8th cervical nerves). The results differ a good deal

* See Fig. 40.

† Foster. Text-Book of Physiology, page 316.

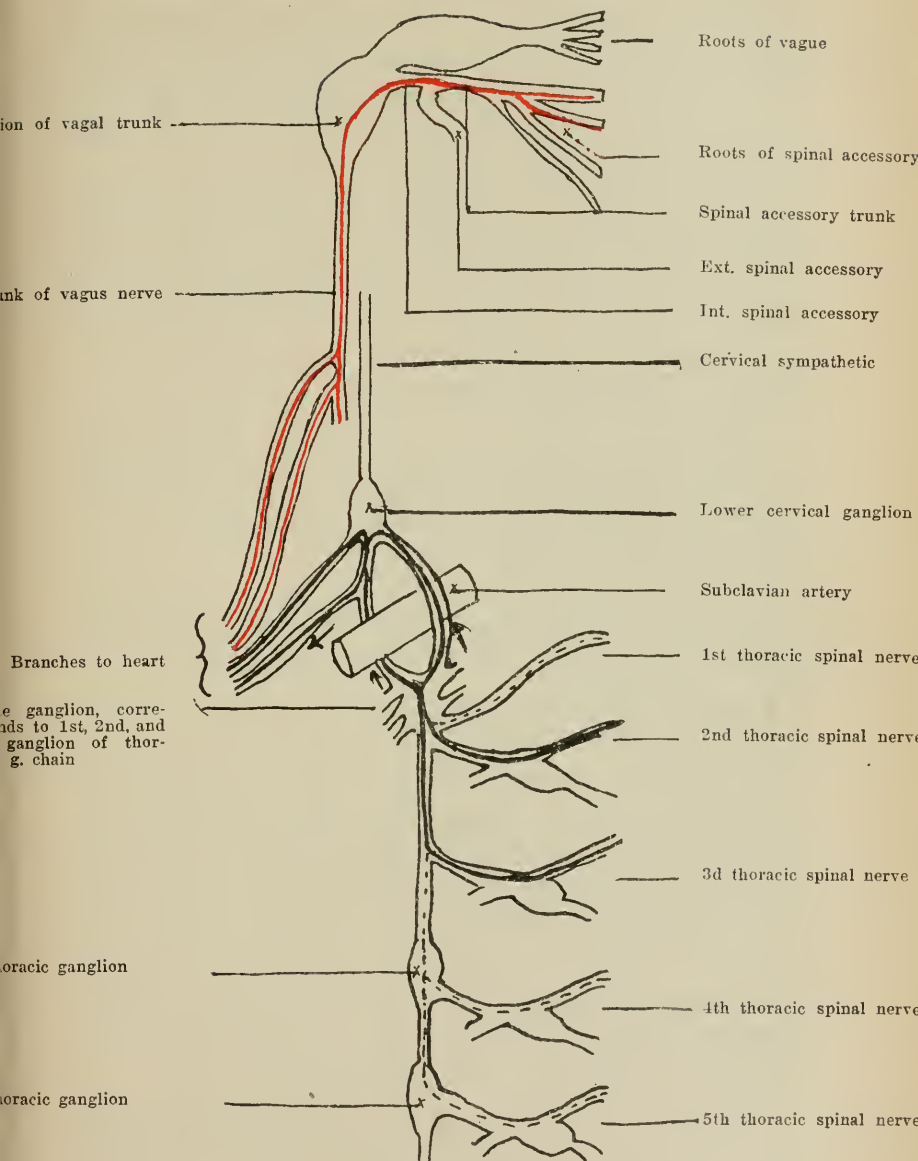

Fig. 41.—Diagrammatic representation of cardial inhibitory and augmentor fibres in a dog. Inhibitory fibres (red) run in bulbar roots of spinal accessory, by int. br. of spinal accessory along trunk of vagus and by branches to the heart. Augmentor fibres (heavy black) pass from the spinal cord. (Arrows show course of augmentor fibres.) (After Foster.)

in different individuals, and there are reasons for thinking that the nerves in question may contain efferent fibres other than augmentor fibres by reason of which stimulation of them may give rise to other than pure augmentor effects."

The application of mechanical vibration between the transverse processes of the 7th cervical and 1st dorsal vertebrae, where the 8th cervical nerve has its exit often results in a lowering of the pulse rate as the following cases illustrate.

Miss N. Sitting, pulse 82; lying, pulse 76.
Mr. T. Sitting, pulse 84.

After five minutes' application of vibration between the transverse processes of the 7th cervical and 1st dorsal vertebrae on each side alternately.

Miss N. Sitting, pulse 76; lying, pulse 72.
Mr. T. Sitting, pulse 80.

Sometimes but more rarely vibration applied over the same site gives accelerating effects as:

Mr. —. Sitting, pulse 74.

After five minutes' vibration.

Sitting, pulse 80.

V. Bezold and others have observed that some accelerating fibres are found in the cervical sympathetic. A few accelerating fibres reach the heart through the vagus and their stimulation may cause an accelerated heart-beat or strengthen cardiac contractions. The excitability of the inhibitory vagal fibres is exhausted more quickly than that of the accelerating fibres, "but the vagus fibres are more excitable than those of the accelerans."*

The same authors state that if the nervus accelerans is stimulated, a *long latent period* ensues before the frequency of the heart-beat is affected. If

* Landois & Stirling. Text-Book of Human Physiology. 4th ed., page 854.

the vagus and accelerans fibres are stimulated at the same time, only the inhibitory action of the vagus is induced. If during the stimulation of the accelerans the vagus is suddenly stimulated a reduction occurs in the number of heart-beats; but if vagal stimulation ceases an accelerating effect is again noted. Adrenals tend to *strengthen* and *reduce* pulse-rate, but vagus under excessive oxidation tends to *quicken* it.

The preceding offers an explanation of the varying effects obtained from the application of mechanical vibration over the same site, the element of time—duration of treatment—being important. When vibration was given between the transverse processes of the 7th cervical and the 1st dorsal vertebrae in all cases of cardiac insufficiency that were associated with a high arterial tension, and in most other cases of high tension where vibration has been applied between the transverse processes of the second and third dorsal vertebrae the result has been a lowering of the blood pressure usually accompanied by a lowering of the pulse rate. An increased frequency in the pulse rate has been the exception, not the rule. Occasionally only a strengthening of the pulse beat has occurred with no variation in frequency.

Butler* believes that "increased frequency of pulse may be due to paralysis of the pneumogastric or to irritation of the sympathetic nerves or the intracardiac ganglia."

It is "evident that stimulation of the 'augmentor' fibres," says Sajous† "increases the rapidity and the force of the heart-beat by increasing the func-

* Butler. Diagnostics of Internal Medicine, page 370.

† Sajous. The Internal Secretions and the Principles of Medicine, page 449.

tional activity of the adrenals and, as a result of the increased oxidation processes thus obtained, that of the vagal centers. The excess of adrenal secretion increases the force of the heart-beats, while the over-activity of the vagal centers increases their number." Foster* says, that when the augmentor fibres are stimulated "in the case both of the auricles and ventricles the extent of the systole is increased. It would seem also that both cavities undergo a larger expansion. They are filled with a larger quantity of blood during the diastole." The heart's work is increased.

Von Ziemssen found that when *mechanical stimuli were applied to the heart from without,* "slight pressure on the auriculo-ventricular groove caused a second short contraction of both ventricles after the heart-beat." Strong pressure causes the cardiac muscle to act very irregularly. This fact should therefore be considered when exerting pressure with the vibratode over the heart muscles.

Cyriax† who has used manual vibrations over the heart believes "that the vibrations act by tending to restore the normal equilibrium between the two sets of fibres, augmentor and inhibitory, which has become disturbed through increased or decreased excitability of either of them and refers the reader to Levin's‡ statistical report regarding the effect of heart vibration. He noted that in pathological conditions of the heart, tenderness over the 4th and 5th dorsal nerves of the left side was elicited by frictions over said nerves.

The nervous system as a medium for influencing

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* Foster. Text-Book of Physiology, page 317.

† Cyriax. Elements of Kellgren's Manual Treatment, page 192.

‡ Tidskrift i Gymnastik 1892.

the heart's functions is a most important field for the application of vibratory stimulation. Oertel and Graham have for years obtained good results from local treatment so directed. Yet some who consider vibratory stimulation of the nerves of prime importance, vibrate other parts as well. The branches of the spinal nerves sometimes apparently govern more than one function as in the vagus of the frog, the stimulation of which may cause either inhibition or increased activity, "according to the position where the stimulus is applied, the intensity of the stimulus and the condition of the heart."*

Since the limitations of spinal stimulation are not as yet fully demonstrated it will take time and experience with the administration of mechanical vibration and other physical measures to discover their relative values.

The nerves in their various relations will be more fully considered in a following chapter. Local or central stimulation requires selective study of the pathological conditions present to be corrected employing the treatment indicated as based upon the findings and the demonstrated physiological action of mechanical vibration.

Vibration of the heart according to Oertel's or Kellogg's method of manual massage may be accomplished with a nicety of precision and control of force hardly possible to obtain with the hands. With the patient standing, use vibratory friction over the chest walls downward and inward from the axillary line. For this purpose a rubber-covered disc vibratode is preferable. Applied in this manner it helps to perfect expiration and favorably influences the

* Baker and Harris. Kirke's Handbook of Physiology.

heart's nutrition. It is so used in the following conditions:

"1. When the heart muscle is weak from deficient nutrition, anemia or corpulence.

"2. When the arterial system is imperfectly filled and there is passive congestion as a result of insufficiency of the myocardium.

"3. When there are valvular lesions or obstruction to the circulation, the pressure of tumors, or contraction of the pulmonary orifice. Emphysema and curvature of the spine increase the demands of the heart.

"4. As an accompaniment of treatment of the heart by mountain climbing."

Kellogg advocates the period during expiration as the time best adapted for massage of the heart. He wishes the patient to recline, and then manual massage is directed from each axilla "toward the sternum," at the same time applying the greatest force "between the fifth and eighth ribs, the maximum of pressure falling over the latter."

The physical and physiological effects of vibratory stimulation on the circulation will vary with the methods of administration and other physical conditions. When the circulation is accelerated by vibratory stimulation the increased heart's action usually indicates a rise in the arterial tension. Lessened frequency is usually found with lowered tension, dilatation of the blood vessels and increased production of heat. Reflexly an alteration in the exchange of oxygen and CO_2 in the lungs produced by the greater demands for tissue combustion affects the respiration. Mechanical vibration can be so applied as to restore the equilibrium of the blood stream and raise the temperature of the body.

THE EFFECT OF VIBRATION ON THE HEART and blood vessels is described by Cyriax* as follows:

"(a) *On the heart.* That vibration can diminish an excited cardiac action has been shown by Winternitz, Levin, Hasebroek, Nebel, Ziegelroth and Achert. Siegfried found very little effect, Bechterew and Tschigawej, a varying one.

"In stoppage of the heart during chloroform administration Strassmann, Korte, and Kumpf, found a strong manual vibration on the heart one of the best methods of causing it to beat again." (Heart reflex of Abrams. Snow.)

" Heitler found that vibration of the heart set up by the so-called hacking over it raised the tone of the cardiac muscle and diminished the size of the organ." (Abrams' heart reflex. Snow.)

"The theory that heart vibration acts chiefly in a reflex way through the sensory nerves and the vagus has been advocated by Heiligenthal, Nebel, Murray and Lorand. Björksten and Ziegelroth on the other hand, considered that it acted directly on the heart itself; Heitler and Hasebroek incline to this view."

From recent investigations the author may add that mechanical vibration may be applied to induce either an inhibitory action through vagal stimulation, or the heart's action may be accelerated. The pulse rate may also be accelerated or diminished.

"(b) *On the blood vessels.* Most authors, Björksten, Zander, Bechterew, and Colombo, consider that the effect of vibration is to cause the blood vessels to contract and the blood pressure to rise, though, according to some of these mentioned, a subsequent

* Cyriax. "Vibrations and Their Effects." Lecture given before the Ling Association, London, on January 5, 1906.

dilatation with fall of blood pressure may result." (The blood pressure may be made to fall or rise. Snow.)

THE HEART REFLEX described by Abrams* is elicited by: "1. Irritation of nasal mucosa. 2. Irritation of gastric mucous membrane. 3. Irritation of rectal mucosa. 4. Irritation of œsophageal mucosa in act of swallowing. 5. Percussion of muscles. 6. By psychic influences." 7. By intervertebral vibration, or vertebral concussion of the 7th cervical vertebra. This reflex he describes as "a contraction of the myocardium of varying duration." This may be due to an effect sometimes observed by stimulating the accelerators, i.e., to "strengthen the contraction of the heart," which may establish an equilibrium, or accepting Sajous' views the action may be due to a secondary effect on the vagus and indirectly on the adrenals. This effect may be induced by an interrupted vibration or concussion applied to the spine of the 7th cervical vertebra, or as demonstrated by the author by interrupted vibration applied between the transverse processes of the 7th cervical and 1st dorsal vertebrae. Abrams observed that although the reflex is usually more noticeable in the left ventricle, in some cases it is confined to the left ventricle; but, on the other hand, when muscle percussion is used the right ventricle only contracts. Normally this is of short duration.

It is of interest to note the effect of manual frictions on "the lower cervical nerves of the sympathetic system as observed by Cyriax.†

"As a general rule there is temporary vaso-con-

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*Abrams. Spondylotherapy. The Heart Reflex of Contraction, page 201.

† Cyriax. Elements of Kellgren's Manual Treatment, page 162.

striction which is followed by a certain amount of vaso-dilatation with improved and slowed cardiac action." Fainting may often be relieved by this method.

To elicit the heart reflex of contraction the writer uses a ball vibratode with a vibrator regulated to give a percussion stroke of rather low rate. If the vibrator is applied over the spine of the 7th cervical vertebra, the part should be first powdered with a dusting powder and the vibratode be applied over an intervening thickness of rubber belting or leather for protection of the tissues from the friction. The application should be usually for three minutes with a few interruptions. After a rest of one minute, another seance of five minutes is given if the response has been inadequate. Care must be taken not to use too great pressure and no friction should under any condition be allowed, otherwise it may chafe the skin. If intervertebral vibration is employed, the ball should be applied directly upon the skin, alternately on each side of the spine between the transverse processes of the 7th cervical and 1st dorsal vertebrae. A medium rate of speed and full stroke should be used. The latter is the method preferred by the writer. The patient may either sit erect, or lie upon an operating table face down, during the administration.

If mechanical vibration is applied to the precordial region to induce the reflex, the ruber-covered disc vibratode is used. The author reduced the blood pressure 10 mm. on two occasions with local vibratory treatment over the heart in the case of a child.

Dr. Peckham has employed local heart vibration with spinal vibration and auto-condensation and is convinced that the local heart vibration is a great tonic.

In determining the heart reflex of Abrams the *deep cardiac dulness* only is to be considered for the area of superficial dulness will vary with "the position of the overlapping lung-borders." These are of course affected by stimulation of the lung reflex of dilatation "which may diminish the area of superficial dulness even to obliteration."*

In relative valvular insufficiency, in cases in which the valves are otherwise normal, but relaxed and not competent to close the orifices completely, permitting regurgitation, the murmur as present has been caused by Abrams to temporarily disappear by an induction of the heart reflex. The effect is to overcome the dilatation of one of the chambers of the heart, which in these cases is always distended with blood and incompletely discharging its contents at systole. He used the sinusoidal current or mechanical percussion over the precordial region with a percussion hammer to induce the reflex.

Cardiac insufficiency due to myocardial changes or valvular lesions occurs: 1. When hypertrophy does not follow. 2. When the hypertrophied heart is overworked. 3. When degeneration takes away its motor power.

When due to myocardial disease it occurs as follows:†

"1. Arrhythmic form: pulse is irregular, intermittent and lacks force and volume.

*Abrams. Spondylotherapy, page 204.

† Abrams. Spondylotherapy, page 213.

"2. Form with accelerated pulse (tachycardia) and paroxysms of palpitation.

"3. Form with attacks of pulmonary oedema and cardiac asthma, with dyspnoea equally inspiratory and expiratory."

Abrams states that in these cases if "a good heart reflex can be obtained the prognosis is as a rule favorable." He induces the reflex by his method of vertebral concussion of the spine of the 7th cervical vertebra. The author elicited the same reflex by prolonged vibration between the transverse processes. This is accomplished by interrupted vibration with the ball vibratode applied alternately on each side of the spine, between the transverse processes of the 7th cervical and 1st dorsal vertebrae, employing moderate pressure and a fairly low rate of speed for three or five minutes with one long and several short intervals of rest. The author has employed this method with gratifying results in the treatment of cardiac insufficiency characterized by arrhythmia.

To test myocardial insufficiency Abrams compares the blood pressure taken previously with the blood pressure taken after the heart has been concussed with a pneumatic hammer. If the latter figure shows a marked increase, the myocardia is held to be very strong; if there is a marked decrease, myocardial insufficiency is present; if there is a difference of but a few millimeters, there is indication of myocardial sufficiency. The author noted the following:

Mr. L.'s tension, 140mm.

After a few vigorous blows over the precordial region.—Mr. L.'s tension, 155 mm.

This marked rise signified that the myocardium was strong which interpreted according to Abrams,

meant that this patient's pressure would be lowered not by vibration over the 7th cervical which tones up the heart muscle, but over the spines of the 2nd and 3rd dorsal vertebrae or by the writer's method in the intervertebral spaces between the transverse processes of the 2nd and 3rd dorsal vertebrae. A vibration of five minutes' duration over the spinous processes of the 2nd and 3rd dorsal vertebrae in one case caused the tension to drop from 160 to 140 mm. Further vibration between the transverse processes of the 2nd and 3rd dorsal vertebrae gave a further fall to 130 mm.

Myocarditis is amenable to treatment by the induction of the heart reflex if the myocardium responds. Symptomatic treatment by diet, elimination and for the improvement of nutrition are indicated. *The duration of treatment* by the induction of the heart reflex may be five minutes or less or more according to results obtained. In some cases the author has obtained good results in five minutes; in others better results were obtained in ten minutes. Ten minutes is commonly the time required.

Over-strained heart characterized by the presence of ventricular dilatation with feeble heart tones, and an irregular or intermittent, feeble, rapid pulse, has been successfully treated by the induction of the heart reflex.

The author has found the employment of vibration in the same manner very effectual in the treatment of *high blood pressure associated with goitre.* The application for five minutes of interrupted vibration over the spine of the 7th cervical vertebra caused in one case a fall from 125 mm. to 112 mm. Dr. A. B. Hirsh of Philadelphia, to whom the author is

indebted for his assistance in making investigations and demonstrations, noted also a relative softening of the pulse.

Theoretically this method should be applicable to the treatment of *mitral incompetency* particularly when complicated by hypertension, also in mitral stenosis, in which the heart may be slightly enlarged, in *tricuspid regurgitation,* which is a state of relative insufficiency, showing usually an increase in the area of dulness to the right of the sternum and in *tricuspid stenosis* with which dulness is increased especially to the right of the sternum.

Failure of general nutrition, disturbance of the local nutrition of the heart, very severe muscular exertion, and mental emotions also cause an interruption of cardiac compensation.

The induction of the heart reflex may be employed in all conditions of *cardiac insufficiency* occurring in the following conditions if degenerative changes render it incompetent as in hypertrophy, or if the hypertrophied heart becomes overburdened.

Hypertrophy of the left ventricle alone,* or with general enlargement of the heart caused by:

"(a) Conditions affecting the heart itself:

"1. Disease of the aortic valve.

"2. Mitral insufficiency.

"3. Disturbed innervation with overaction, as in exopthalmic goitre, in long continued nervous palpitation, and as a result of the action of certain articles such as tea, alcohol, and tobacco."

"In all of these conditions the work of the heart is increased. In the case of the valve lesions the in-

* Osler. Practice of Medicine, page 629.

crease is due to the increased intraventricular pressure."

"(b) Conditions acting on the blood vessels:

"1. General arteriosclerosis with or without renal disease.

"2. All states of increased arterial tension induced by the contraction of the smaller arteries under the influence of certain toxic substances, which affect 'the minute capillary circulation,' render greater action necessary to send the blood through the distant subdivisions of the vascular system.

"3. Prolonged muscular exertion."

"Hypertrophy of the right ventricle is caused by:

"1. Lesions of the mitral valve, either incompetence or stenosis causing increased resistance in the pulmonary vessels.

"2. Pulmonary lesions, obliteration of any number of blood vessels within the lungs as in emphysema or cirrhosis.

"3. Valvular lesions on the right side occasionally cause hypertrophy in the adult.

"4. Chronic valvular disease of the left heart and pericardial adhesions."

"Dilatation with hypertrophy :

Of the left auricle.	1. In lesions at the mitral orifice such as mitral stenosis.
Of the right auricle.	1. When there is greatly increased blood pressure in the lesser circulation as in mitral stenosis or pulmonary lesions.
	2. Narrowing of tricuspid orifice.

The heart reflex of contraction is also of use theoretically in the treatment of dilatation of the heart when due to* "a weakened wall yielding to a normal distending force." When the dilatation is due to "a normal wall yielding under a heightened blood pressure," vibration applied in the intervertebral spaces between the 2nd and 3rd dorsal vertebrae or to their spines should be indicated.

"A weakened wall† occurs in:	1. Myocarditis in fevers and infections. 2. Acute endocarditis or pericarditis. 3. Anemia, leukemia, and chlorosis.
A normal wall yields to heightened blood pressure when an increased quantity of blood is to be moved or an obstacle is to be overcome. The pressure may bring only hypertrophy.	1. Severe muscular effort. 2. All forms of valve lesion. 3. All conditions increasing the tension of the blood in the pulmonary vessels as emphysema."

Dr. Victor G. Vecki‡ reports a case of heart failure treated by spinal concussion as follows:

"A moribund patient had an apex pneumonia and during the course of her disease the conventional cardiac stimulants were employed. Suddenly during the night, however, she became extremely cyanotic and pulseless and it was determined to concuss the seventh cervical spine to awaken, as it were, the

* Osler. Practice of Medicine, page 635.

† Osler. Practice of Medicine, pages 635, 636.

‡ Physiologic Therapeutics, September, 1910.

enervated heart. No percussion apparatus was at command and, in lieu of the latter, the palmar surfaces of the fingers were applied to the seventh cervical spine, and, with the clenched fist, the dorsal surfaces of the fingers were struck a series of short and vigorous blows. (Whether the sympathetics were acted upon or the vagus wisely and repeatedly affected producing activity is not yet determined. The writer has raised the arterial tension from 140 to 160 mm. with a two-minute vibratory treatment between the 7th cervical and 1st dorsal vertebrae. The pulse was at the same time increased from 64 to 70 beats per minute).

"The latter method of concussion was continued for about ten minutes with intervals of rest. Soon after concussion was commenced the cyanosis became less evident and the pulse was again perceptible. Every two hours during the night this method was continued and thereafter at less frequent intervals until convalescence was established. It was evident to the nurses and others that after each seance of the concussion treatment there was an immediate evanescence of the cyanosis and the pulse always became stronger and less frequent." Dr. Vecki also considers it of value in pneumonia.

THE HEART REFLEX OF DILATATION* (Abrams) is elicited by spinal concussion of the 9th, 10th, 11th and 12th dorsal vertebrae. He notes that here is an increase in the area of dulness but no increase in the diameters of the heart as shown by the X-ray. The heart can increase the size of its chambers without increasing "the tension of its walls."

*Abrams. Spondylotherapy, page 221.

Angina pectoris is due to an organic lesion—sclerosis of the coronary arteries—with consequent inability to respond to the normal impulses of their vaso-motor nerves which otherwise regulate the volume of blood supplied to the heart muscle, and the increased resistance of a general circulation under these conditions constitutes a grave complication—"increased demand for work to be done by the poorly nourished heart." Toxaemia, directly or indirectly is the underlying cause, and its removal is indicated. A restricted diet devoid of meat and limited in quantity is important.

For relief of the condition Abrams recommends a trial of "concussion of the lower dorsal vertebrae" to induce a heart reflex of dilatation. The writer believes, as a preventive measure, however, that as angina pectoris is accompanied by increased arterial tension, the lowering of the blood pressure is naturally indicated to lessen the labor of the heart. This may be accomplished by mechanical vibration or high frequency auto-condensation.

Pseudo-angina of which there are three forms, neurotic, vaso-motor, and toxic, should be treated as indicated by their causes.

Cardiac asthma is sometimes relieved by vibrating between the transverse processes of the 7th cervical and 1st dorsal vertebrae.

Aneurysms of the thoracic aorta* may be according to Bramwell:

1. Latent with no physical signs.
2. Those which cause intrathoracic pressure.

* Osler. Practice of Medicine, page 672.

3. Those which appear as tumors and that cause pressure and other symptoms.

An aneurysm may cause an abdominal pulsation on either side of the sternum "usually above the level of the third rib and most commonly to the right of the sternum, either in the first or second interspace." If the innominate is affected the pulsation may be at the sternal notch or in the neck. Posteriorly the left scapular region is the usual site for pulsation when present. Aortic aneurysm in chronic aortitis may cause interscapular pain "especially on the left side."

To diagnose the presence of aneurysm other than by the use of the X-ray, vertebral or intervertebral vibration or concussion is used. Abrams found that the aortic reflex of contraction lessens the symptoms and the reflex of dilatation accentuates their presence.

Normally *the transverse dulness** *of the aorta* at the level of the manubrium is 2 or 3 cm. to the right of the sternum and 1.5 to 2.5 cm. to the left of the medial line. If the transverse dulness at this point exceeds 5 cm., it indicates a dilated aorta or an aneurysm.

THE AORTIC REFLEX OF CONTRACTION produces a diminished area of dulness corresponding to the position of the aorta. It is induced by vibrating between the 7th cervical and 1st dorsal vertebrae and is used in diagnosing thoracic aneurysm as cited in Chapter VI as well as in its treatment,—according to Abrams,† ten minutes' concussion of the spine of the 7th cervical vertebra. It contracts the aneurysm and favorably affects the symptoms present. The

*Abrams. Spondylotherapy, page 258.

† Abrams. Spondylotherapy, page 261.

author would suggest the application of intervertebral vibration between the transverse processes of the 7th cervical and 1st dorsal vertebrae.

Aneurysm of the abdominal aorta connected with the front of the aorta near the coeliac axis, forms "a pulsating tumor* in the left hypochondriac or epigastric regions usually attended with symptoms of disturbance of the alimentary canal as sickness, dyspepsia, or constipation and accompanied by pain which is constant, but nearly always fixed in the loins, epigastrium, or some part of the abdomen, radiating pain being rare."

When an aneurysm of the abdominal aorta communicates with the back part of the abdominal aorta the pulsating tumor "presents itself in the left hypochondriac or epigastric regions" with alimentary canal disturbances. Pain usually occurs as fixed in the back caused by pressure or displacement "of branches of the solar plexus and splanchnic nerves and as lancinating pain along those branches of the lumbar nerves pressed upon."

Normally over the 12th dorsal vertebra resonance is obtained; but, if the 9th, 10th, 11th and 12th dorsal vertebrae be concussed (Abrams) or in the author's opinion, their intervertebral spaces vibrated, the resonance gives way to a dulness on percussion which dulness measures about 5 cm. (Abrams). If this dulness at the 12th dorsal vertebra is greater than 6 cm. he interprets it to mean "a dilated aorta and if the dulness is irregular," an aneurysm.† He induces a reflex contraction of the abdominal aorta by concussion of the spine of the 7th cervical

* Keen. Gray's Anatomy, page 573.

† Abrams. Spondylotherapy, page 266.

vertebra. The author has demonstrated that for this other effects vibration of the intervertebral spaces produces the same results as concussion of the spine and in this instance advises vibration between the transverse processes of the 7th cervical and 1st dorsal vertebrae.

THE AORTIC REFLEX OF DILATATION* causes an increase in the dulness normally present and an increase in the symptoms if an aneurysm be present. It is elicited by vertebral concussion of the last four dorsal vertebrae and is induced by affecting the vaso-dilators. (Abrams.) Intervertebral vibration as in other cases will produce the same effect.

PALPITATION OF THE HEART may be present in "an organic† condition of the heart itself, especially where the cardiac muscles are weak, in cases of dilatation and hypertrophy of the left ventricle, where the heart is gradually becoming unable to overcome the resistances offered to its work, and especially during exertion when the heart is taxed above its strength." Spinal vibration with the ball vibratode between the transverse processes of the 7th cervical and 1st dorsal vertebrae is indicated. Palpitation also occurs when there is low blood pressure as in anemia and in fatty heart where there is increased muscle excitability. Direct or reflex nervous conditions may cause it as stomach or bowel derangements.

If dilatation of the stomach be present, vibration or lavage of that organ should be employed before treating the functional condition directly. If a

*Abrams. Spondylotherapy, page 22.

† Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 70.

uterine fibroid is the cause, the X-ray should be systematically employed to reduce it, unless surgical intervention is found to be absolutely necessary. Palpitation should be treated as a symptom, and the cause discovered and remedied when possible. Mechanical vibratory treatment should be employed as indicated.

If there be heat flushes, tachycardia, or irregular heart action, mechanical vibration is indicated alone, or as conditions demand, combined with other appropriate physical measures, as light, static electricity, or hydrotherapy. Heat flushes associated with a high blood pressure can be benefited by interscapular vibration between the 2nd and 3rd dorsal vertebrae, if there is no cardiac insufficiency, associated with dietetic and hygienic measures, daily baths and outdoor exercise. The frequency of tachycardia may be lessened by spinal vibration with the ball vibratode applied in the interscapular region or abdominal vibration with the disc vibratode, or if due to cardiac insufficiency vibration between the transverse processes of the 7th cervical and 1st dorsal vertebrae is indicated. Interrupted vibration with the rubber covered disc vibratode employing moderate pressure, applied to the solar plexus and the lumbar ganglia (two inches on each side of the umbilicus) in succession, making the application three, four or five times at a sitting, has a marked effect on the sensations of internal heat, the effect depending on the strength of the stimulus. If the stimulus be too strong or too prolonged, it will not control the condition. External parts are warmed by lowering the blood pressure.

In the study of blood pressure four factors are to be considered.*

"1. Rate or force of heart-beat. If increased the pressure rises, and *vice versa.*

"2. Resistance of blood flow especially peripheral. (a) Decrease or increase in width of vessels results normally in a vaso-constriction of the small arteries with increased arterial and diminished venous pressure or vaso-dilation with diminished arterial and increased venous pressure.

"3. Elasticity of the arteries.

"4. Quantity of blood in the system. Great loss would cause a fall of blood pressure."

In general the first three factors concern us the most and of the three the first two are of prime importance. As blood pressure is being more closely studied, high pressure is found not to be so frequently due to arteriosclerosis as formerly thought; but to be the ultimate cause. Auto-intoxication is the most common cause of hypertension, and the ultimate cause of arteriosclerosis.

The first two factors depend on (a) the demands for work to be done either from the demands of exercise or hypertension, causing variations in the ventricular force which varies the demands on the heart muscle, and (b) vaso-constrictor effects.

Two states are recognized in cardiac weakness:†

"1. If the cardiac ventricular force is weak and vaso-constrictors compensate the blood pressure may be high.

"2. If the cardiac ventricular force is weak and

* Howell. Text-Book of Physiology, page 499.

† Abrams. Spondylotherapy, pages 248 and 253.

vaso-constrictors do not compensate, the blood pressure is low."

MYOCARDIAL INSUFFICIENCY has already been considered but another easy method of testing it as noted by Abrams is to compare the pulse taken with the patient lying and sitting. When he is sitting the pulse should show an increase of four to six beats per minute. If instead it is lessened, the pulse rate being higher when lying than when sitting, it indicates cardiac insufficiency. An illustrative case that came to my notice was as follows:

	Tension	Pulse
Dr. F. Lying	140 mm.	90
Sitting	140 mm.	82

After interrupted vibration was applied between the transverse processes of the 7th cervical and 1st dorsal vertebrae, the conditions reversed as follows:

	Tension	Pulse
Sitting	145 mm. immediately after.	
Lying	135 mm. a few minutes later.	84
Sitting	135 mm.	90

It may be here noted that a temporary rise in arterial tension may be noticed to be followed later by a fall.

VASO-MOTOR INSUFFICIENCY is determined as follows by Abrams' method used by the writer.

Patient A.

Blood pressure taken in recumbent position	180 mm.
Blood pressure taken in sitting position	168 mm.
A fall of	12 mm.

The fall shows an abnormal relation indicative of vaso-motor or vaso-constrictor insufficiency.

Patient B.

Blood pressure taken in recumbent position	90 mm.
Blood pressure taken in sitting position	102 mm.
An increase of	12 mm.

The rise shows the normal relation in which the vaso-constrictors acted. They increased the resistance by the normal constrictor effect, which caused a rise of arterial tension with its accompanying fall of venous pressure.

SPLANCHNIC NEURASTHENIA* (so-called by Abrams) is characterized by abdominal sensitiveness, tenderness and enlargement of the liver, gaseous accumulations and an exaggeration of the "cardio-splanchnic phenomenon" so-called by Abrams. If the lower part of the sternum "contiguous to the heart" is percussed it is resonant or hyperresonant. If the patient then lies down and the same area is percussed, after compressing vibration has been applied to the stomach, it will be dull or flat in the normal person—the cardio-splanchnic phenomenon. In splanchnic neurasthenia this phenomenon is exaggerated, there is an increased area of dulness.

Splanchnic neurasthenia is treated by spinal vibration. There is under these conditions an accumulation of blood in the splanchnic area owing to a lack of tone in the vaso-motor nerves. This condition may cause syncope. If the ball vibratode be employed to give intervertebral vibration between the 2nd and 8th dorsal vertebrae for five minutes or so, the cardio splanchnic phenomenon is shown. It tones up the vaso motors of the splanchnic vessels and thereby lessens intra-abdominal congestion. Conditions associated with relaxed abdominal parts and intra-abdominal stasis are benefited by the same treatment. In studying these cases the author has noted as Abrams previously noted, that in those so affected, there is lower blood pressure when sitting

*Abrams. Spondylotherapy, page 345.

or standing than when lying, as the following cases will illustrate.

		Tension	Pulse
Mr. H.	Lying	148 mm.	72
	Sitting	135 mm.	82
		13 mm.	

		Tension	Pulse
Mr. W.	Lying	135 mm.	65
	Sitting	126 mm.	72
		9 mm.	

The author vibrated these patients between the 2nd and 3rd dorsal vertebrae with the ball vibratode and lowered the tension with a reversal of conditions—the tension being higher when sitting than when lying. In cases characterized by a cardiac insufficiency, vibration between the 7th cervical and 1st dorsal vertebrae has reversed conditions. Abrams speaks of five methods among which is abdominal massage which has the same effect on the pulse rate as interscapular vibration or vibration between the transverse processes of the 2nd and 3rd dorsal vertebrae. In some cases the author's experience agrees with that of Abrams in that concussion of the 2nd to 8th dorsal spines relieves "intraabdominal congestion." The patients immediately feel relief.

A case presenting the symptoms of a splanchnic neurasthenic had the following record.

	Tension	Pulse
Lying	110 mm.	62
Sitting	108 mm.	60

In this case there was a cardiac and a vaso-motor insufficiency. The cardiac insufficiency was treated by vibrating between the transverse processes of the

7th cervical and 1st dorsal vertebrae with the ball vibratode, with the following result.

	Tension	Pulse
Lying	108 mm.	66
Sitting	110 mm.	66

The sphygmomanometer according to Abrams* measures only the force of the left ventricle; for the determination of the sufficiency of the right ventricle he uses auscultation.

The following is Howell's view of vaso-motor reflex of *control of the rise and fall of arterial pressure.*

"Afferent† fibres giving vaso-motor reflexes.	I. Pressor fibres. Cause vascular constriction and rise of arterial pressure from reflex stimulation of the vaso-constrictor center—*e.g.*, sensory nerves of the skin.
	II. Depressor fibres. Cause vascular dilatation and fall of arterial pressure from reflex inhibition of the tonic activity of the vaso-constrictor center—*e.g.*, depressor nerve of heart.
	III. Depressor (or reflex vaso-dilator) fibres. Cause vascular dilatation and fall of arterial pressure from stimulation of the vaso-dilator center—*e.g.*, erectile tissue, congestion of glands in functional activity.

HIGH BLOOD PRESSURE is caused by pain, chronic inflammation of the kidneys which leads to cardiac hypertrophy, and an increase in peripheral resistance due to the vaso-motor disturbances. Cardiac hypertrophy with dilatation, Graves' disease, goitre, and some neuroses increase the tone of the vaso-motors.

LOW BLOOD PRESSURE is present with exhausting diseases, infections, the insomnia of low resistance, cardiac failure, hemorrhages, chlorosis and in advanced tuberculosis.

*Abrams. Spondylotherapy, page 244.

† Howell. Text-Book of Physiology, page 600.

Foster observes that the "*general arterial tone of the body is maintained and that an increase or decrease of vaso-constrictor action,* in particular arteries or in arteries generally is brought about by means of the *bulbar vaso-motor center.*"

BLOOD PRESSURE WHEN LOWERED BY STIMULATION OF THE DEPRESSOR falls gradually. If the heart-beat* is not markedly changed with a lowered blood pressure, the fall of pressure must be due "to the diminution of peripheral resistance occasioned by the dilation of some arteries." He believes that possibly "those dilated are chiefly those of the abdominal viscera, governed by the splanchnic nerves."

In man a nerve homologous to the depressor in a rabbit is found arising "from the vagus from the junction of the vagus and superior laryngeal nerves, but quickly joins again the main trunk of the vagus.† Almost all parts of the vascular system can be thrown into dilatation by the depressor nerve" and therefore a fall of blood pressure ensues, which Sajous attributes to "the depressor nerve inhibiting the functions of the thyroid gland and pituitary body, and through the latter that of the adrenals."‡

When the central end of the depressor nerve in a rabbit was stimulated "a surprising fall of arterial pressure accompanied by a slight decrease in cardiac frequency" ensued (Ludwig and Cyon||).

THE "DEPRESSOR NERVES are those through which the adreno-thyroid center regulates the circulation of

* Foster. Text-Book of Physiology, page 343.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1125.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 1126.

|| Sajous. The Internal Secretions and the Principles of Medicine, page 1125.

the anterior pituitary body and of the thyroid apparatus.* The depressor nerve can "inhibit the functions of the thyroid gland and anterior pituitary body by constricting their arteries." (This "reduces general oxygenation and metabolism throughout the entire body, including the muscularis of all vessels, thus causing them to relax, i.e., to dilate.) It also influences the abdominal and peripheral vessels."†

BLOOD PRESSURE WHEN LOWERED‡ BY CARDIAC INHIBITION (*vagal stimulation*) *falls suddenly.*

Blood pressure may be affected "by stimulating or depressing one or more centers in the spinal system, and particularly and in many instances solely, those located in its chief center—the posterior pituitary body."

BLOOD PRESSURE MAY BE LOWERED by depressing *the sympathetic center* which causes a general dilation of the arterioles which "allows an excess of arterial blood to enter the capillaries in general." This passive hyperemia of the capillaries may when excessive "excite the peripheral end-organs of sensibility," and tingling, flushing and headache are induced.

BLOOD PRESSURE MAY BE LOWERED by inhibiting the functional activity of the *vaso-motor center.* The depression of the vaso-motor center permits the blood vessels to dilate. The blood retreats as it were from "all peripheral structures, the skin, cerebral spinal system, etc., including the pituitary body, to collect in the great central channels," in consequence of

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* Sajous. The Internal Secretions and the Principles of Medicine, page 1133.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1128.

‡Foster. Text-Book of Physiology, page 344.

which "the functions of all centers including the adrenal center are likewise depressed, and the production of adrenoxidase being correspondingly reduced, general nutrition is impaired. Depression of the vaso-motor center causes "ischaemia of the peripheral organs and therefore the hypothermia and cyanosis sometimes witnessed."*

These observations are of importance to the practitioner who uses the vibrator scientifically whether in research work or therapeutically.

BLOOD PRESSURE MAY BE MADE TO RISE OR FALL "BY AFFERENT† IMPULSES passing along other nerves than the depressor." When afferent nerve stimulation induces a rise in arterial tension and there is no "increase in the heart-beat, such at least as could give rise to it, the rise must be due to the constriction of certain arteries." Foster believes that the arteries affected are "those of the splanchnic area certainly, and possibly, those of other vascular areas as well." When afferent nerve stimulation shows a fall, the result is "very similar to that caused by stimulating the depressor." He‡ observes, furthermore, that "the condition of the central nervous system seems to determine whether the effect of afferent impulses on the central nervous system is one leading to augmentation of vaso-constrictor impulses and so to a rise, or one leading to a diminution of vaso-constrictor impulses and so to a fall of blood pressure."

In connection with the lowering of blood pressure it is of interest to note (Fig. 41), the arrangement of the augmentor (sympathetic) fibres in a dog. The

* Sajous. The Internal Secretions and the Principles of Medicine, page 1310.

† Foster. Text-Book of Physiology, page 344.

‡ Foster. Text-Book of Physiology, page 345.

rami communicantes connect the sympathetic with the 2nd and 3rd dorsal nerves whose exits in man are between the 2nd and 3rd and 3rd and 4th dorsal vertebrae which are reached by intervertebral vibration between the 2nd and 3rd, and the 3rd and 4th dorsal vertebrae. Mechanical vibration in man in these sites for five minutes, followed by a brief interval of rest, and then another five minutes of vibration, will often reduce blood pressure. Whether we affect the pneumogastric (see page 184) or filaments noted by Bradford and Dean* that emerge from the cord located from the 2nd to 6th dorsal, "and in respect to maximum effects on a level with the 3rd, 4th and 5th nerves, which cause pulmonary vaso-constriction and a fall of aortic pressure," is to be determined. The pulmonary vaso-constrictors ascend the chain up to the 1st thoracic ganglion. The 2nd to the 6th dorsal nerves may be related through their origin to the 6th and 7th cervical, and 1st, 2nd, 3rd, 4th and 5th dorsal vertebrae. (See Table Chapter VI.)

In the TREATMENT OF HIGH BLOOD PRESSURE the cause must be removed if possible, and measures, hygienic, preventive, or therapeutic, be taken to abate or diminish it. If due to arteriosclerosis, two stages should be noted.† The first stage includes (1) "general adynamia, which entails (2) hypocatabolism and therefore, an accumulation of toxic wastes in the blood, the cause in turn of (3) the vascular lesions." The second stage is marked by functional derangements of organs due to noticeable organic lesions. Two indications are to be met:—(1) to reduce the

* Sajous. The Internal Secretions and the Principles of Medicine, page 474.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1560.

waste products, and (2) to counteract the morbid process by drugs or physical measures* which affect the depressor† nerve, causing "constriction of the arterioles through which the anterior pituitary and the thyroid apparatus are supplied with blood. The supply of adrenoxidase (besides thyroidase) being diminished, the metabolic activity in the vascular walls is reduced, and the chief pathogenic process is thus controlled."

In the second stage, if the tension is high, vibrate to support the hypertrophied heart.

As before stated high blood pressure can be lowered by vibrating in the intervertebral space between the 2nd and 3rd or 3rd and 4th dorsal vertebrae, unless there is a weakened heart muscle with compensatory vaso-constriction (Abrams) when it can be lowered by vibrating in the intervertebral space between the transverse processes of the 7th cervical and 1st dorsal vertebrae.

Abrams noted that concussion on the 7th cervical caused rise of temperature. Sajous notes that the path to increase heat is down the cord to the 1st, 2nd and 3rd dorsal nerve. The first dorsal nerve has its origin at the level of the 6th and 7th cervical vertebrae (Krause). Consequently we must reach the governing center of the adrenals.‡

HIGH PRESSURE FOLLOWING IN SPASMODIC DISCHARGE STIMULATION OF THE VASO-MOTOR CENTER ALONE, is noted in an experiment by Hill cited by Sajous. "The vaso-motor center can be stimulated inde-

* The author.

† Sajous. The Internal Secretion and the Principles of Medicine, page 1562.

‡ Sajous. The Internal Secretions and the Principles of Medicine, pages 1023 and 1024.

pendently of the sympathetic center and *vice versa*. Excitation of the vaso-motor center* causes "constriction of the larger and deeper vessels in consequence of which an increased volume of blood is forced towards the periphery. The arterioles may not only remain passive under these conditions, but they may be forcibly dilated by the centrifugal streams, and the blood invade the tissues" causing "excessive hyperæmia."

Masay† demonstrated that STIMULATION OF THE PITUITARY BODY (which is a vaso-motor center) or of the medulla oblongata including the BULBAR VASO-MOTOR CENTER caused a sudden rise of blood pressure followed by a fall when excitation ceased.‡ Stimulation of the pituitary constricted all the arterioles through sympathetic fibres controlled by the sympathetic center. The high blood pressure was caused by arteriole constriction and "resulting accumulation and pressure behind the vascular obstruction."||

When the SYMPATHETIC CENTER§ IS STIMULATED the sympathetic terminals whose function is to regulate the "mean calibre of the arterioles during their dilation and contraction at each pulsation exaggerate this function: they reduce this mean calibre. Some drugs as digitalis at first or when small therapeutic doses are given, *increase* the propulsive activity of the arterioles for the abnormal narrowing of these

* Sajous. The Internal Secretions and the Principles of Medicine, page 1206.

† Sajous. The Internal Secretions and the Principles of Medicine, page 985.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 988.

|| Sajous. The Internal Secretions and the Principles of Medicine, page 992.

§ Sajous. The Internal Secretions and the Principles of Medicine, page 1206.

vessels is followed by their reflex dilation (stricto-dilation—Sajous) the increase of the propulsive power being due to the fact that both dilation and contraction of the vessels are exaggerated. Gradually as the dose is increased, the sympathetic stimuli become so energetic that the arterioles are kept constricted, the vaso-dilator reflex action being increasingly overpowered." When constriction causes obliteration of their lumen, "circulation in the heart muscle" is arrested and death follows.

Reichert,* Vulpian, Mayer and Klapp found "that after division of the upper portion of the spinal cord (the path also of the adrenal secretory nerves) strychnine could no longer raise the arterial pressure."

When the ADRENO-THYROID CENTER† IS STIMULATED there results an increase in oxidase and thyroidase (thyroid and parathyroid secretion). Sajous says "This means that the protective properties of the blood are enhanced by augmenting its proportion of auto-antitoxin." As the adrenal center is the heat or thermogenic center "there is a rise of temperature."

The effects of digitalis illustrates the STIMULATION OF THE "TEST ORGAN AND THROUGH IT THE ADRENAL CENTERS, AND ALSO, but with less violence, THE SYMPATHETIC CENTERS (only when the average therapeutic dose is given), which enhances the propulsive action of the arterioles. The drug increases the arterial pressure largely by increasing the peripheral resistance without centric vaso-motor stimulation" which Sajous believes indicates that the adrenals are

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* Sajous. The Internal Secretions and the Principles of Medicine, page 1226.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1206.

"the source of the vaso-constricting influence, for Langley found, in a series of experiments with adrenal extract, that its action 'runs parallel with the action of the sympathetic nerves on the blood vessels' and that 'in many cases the effects produced by the extract and by electrical stimulation of the sympathetic nerve correspond exactly.' As the peripheral arterioles are governed by the sympathetic, the adrenal secretion corresponds in its action with that of this nerve, because its action (as adrenoxidase) on the arterioles is the first to manifest itself, owing to their diminutive size. Digitalis acting mainly through the adrenal secretion also increases the peripheral resistance." Von Broeck noted in regard to the effect of digitalis on metabolism; that the elimination of urea and carbon dioxide was increased while the blood pressure was high and was diminished with its fall.

BLOOD PRESSURE MAY BE RAISED† by stimulation of the TEST ORGAN AND IN CONSEQUENCE THE ADRENAL CENTER. An increased production of adrenal secretion increases the contractility of the right ventricle, and also increases the quantity of adrenoxidase in the blood, and thus increases the organic metabolic activity. The heart muscle and the arteries receive more nutrition and become more active, and thus raise blood pressure.

From experiments* STIMULATION OF THE VERTEBRAL NERVE, made up of four or five of the lower cervical nerves, through the rami communicantes, causes an

† Sajous. The Internal Secretions and the Principles of Medicine, page 1222.

* Sajous. The Internal Secretions and the Principles of Medicine, pages 1012, 1013.

increased vascular tension in the liver due to the general rise of blood pressure probably due to the production of an excess of adrenoxidase, caused by the excessive adrenal secretion. "Hardly any other agent will produce such an enormous increase of pressure" writes Schäfer referring to injections of adrenal extract after division of the vagi, as direct stimulation of the vaso-motor center. The writer has observed the following in respect to vibration with the ball vibratode between the transverse processes of the 2nd and 3rd cervical vertebrae.

Mr. S. Tension 110 mm. Pulse 74. After two minutes' vibration, tension 116 mm. Pulse 72.

Mrs. S. Tension 106 mm. After two minutes' vibration, tension 112 mm.

Adrenoxidase, according to Sajous, is the "activating agent in all metabolic processes. An excess in the blood enhances its oxygenizing power in proportion." This blood in the vasa vasorum of the arteries and veins, he states abnormally stimulates and contracts the muscular portion of the vessels, reducing their calibre.

The blood tension can be raised empirically (Abrams) when low by applying vibration in the intervertebral spaces between the transverse processes of the 6th and 7th dorsal vertebrae. If due to a weakened heart muscle, associated with no compensatory action on the part of the vaso-motors, by vibrating in the intervertebral space between the 7th cervical and 1st dorsal, the pressure may be raised in some cases.

During experimental work with the vibrator the author has caused the blood tension to rise from 140 mm. to 160 mm., the vibration being applied for

two minutes between the transverse processes of the 7th cervical and 1st dorsal vertebrae.

Mr. L .

Before treatment,	pulse	68,	tension	130	mm.
After ½ minute treatment,	"	64,	"	140	"
After ½ minute more treatment,	"	68,	"	140	"
After 1 minute more treatment,	"	70,	"	160	"

The influence of the stimulation may last for some time after treatment. Possibly the accelerating fibres of the vagus were stimulated. Blood pressure is sometimes lowered and the pulse beat strengthened by vibrating at the same site, noted especially when there is a weak heart muscle with compensatory vasomotor action (Abrams). In which event the inhibitory fibres of the vagus respond to stimulation and its accelerating fibres respond "by strengthening the contraction of the heart" as Heidenhain, Lowit and Pawlow have noted as possible, or the governing path* to the adrenals may be reached and inhibition of adrenal activity result. A re-establishment of equilibrium follows with consequent fall of pressure. Possibly this is due to the action of the vagus noted by Landois when the accelerators and the vagus are both irritated. If the vagus and accelerator are irritated "simultaneously† only the inhibitory action of the vagus makes its appearance."

When we vibrate in the intervertebral space between the 7th cervical and 1st dorsal vertebrae, the sympathetics (inf. cervical ganglion) may sometimes respond and induce results as heretofore noted experimentally by other methods in the hands of other observers; because the *inferior cervical* ganglion is

* Sajous. The Internal Secretions and the Principles of Medicine, page 1024.

† Landois. Text-Book of Human Physiology, page 761.

situated "between the base of the transverse process of the last cervical vertebra and the neck of the first rib. The head of the first rib articulates with the body of the first dorsal vertebra."

THE EFFECT OF MECHANICAL VIBRATION ON THE LUMEN of the arteries is influenced by their elasticity and tonus which normally controls the blood pressure, thereby equalizing the blood current and determining the amount sent to each part, their lumen being under the control of the vaso-constrictors and vaso-dilators or rather stricto-dilators. Their elasticity and the responsive action of the vaso-motor nerves regulate the blood supply to the organs and tissues of the body. It must be remembered that when the *arteries* contract, the capillaries which have no muscular walls dilate, owing to the pressure exerted; and when the arteries dilate, the capillaries contract owing to the resiliency of the latter.

THE EFFECTS OF MECHANICAL STIMULI "ON BLOOD VESSELS may be due to their action on the peripheral nervous mechanism (supposed ganglia along the course of the vessels). The arteries may contract so much as to almost disappear, but sometimes," observes Landois and Stirling, "dilatation follows the primary stimulus." It has been found that in order to obtain the maximum vaso-constrictor effect (by stimulating the center) as indicated by the maximum blood pressure from 10 to 12 strong or 20 to 25 moderately strong shocks in one second are necessary. Waves of vaso-constriction and vaso-dilatation may occur in succession from frictions (manual) is the belief of Cyriax.*

Consideration of the vaso-constrictors and vaso-

* Cyriax. Elements of Kellgren's Manual Treatment, page 152.

dilators belongs properly in the chapter devoted to the relation of mechanical vibration to the nervous system. Their relation, however, to the study of the blood vessels and the manner of influencing pathological states depending on the constriction and dilatation of said blood vessels renders it necessary to refer to them here. The author wishes to call attention to Sajous'* conclusions on the subject which are as follows:

"1. That it is the function of the *sympathetic center* (in the posterior pituitary body) and of the *sympathetic system* to *govern the calibre* of all arterioles, and to regulate, through the spiral muscular coat of these vessels, the volume of blood admitted into the capillaries of any organ, including those of the brain and nervous system.

"2. That the vaso-motor center *governs the calibre* of the larger vessels only, *i.e.,* of all vessels that are larger than the arterioles:—veins and larger arteries.

"3. That *active vaso-dilation* exercised through *vaso-dilator nerves* is limited to the arterioles.

"4. *That dilation of an arteriole is due to constriction by the terminal fibres of a cranial nerve* (the vagus, for example) of the *vasa vasorum* which supply its walls with adrenoxidase-laden plasma, thus causing ischaemia and relaxation of its muscular coat.

"5. That while this process, *"stricto-dilation,"* serves to admit an excess of blood into an organ when the functional activity of the latter is to be

* Sajous. The Internal Secretions and the Principles of Medicine, page XII. Volume II.

increased, the sympathetic fibres, when the organ's functions are to cease, restore the arterioles to their normal calibre.

"6. The cranial and sympathetic filaments distributed to the arterioles carry on an additional and more important function than that of maintaining their tonus.

"7. These nerves, owing to the presence in the walls of the arterioles of spirally disposed muscles, endow these vessels with a special property; that of increasing the *vis a tergo* motion of the blood in order to overcome the resistance of the capillaries."

"8. The *sympathetic center* (in the posterior pituitary body) *provokes sleep by constricting arterioles* of the anterior pituitary (including its test organ which governs the adrenals) and arterioles of the thyroid thereby lowering the functional activity of the anterior pituitary body and of the adrenal system. Lowered metabolic activity follows, which in cardiac and vascular muscular fibres, causes a *general vasodilation,* resulting in an accumulation of blood in the splanchnic area, and ischaemia of the cerebrospinal system."

Sleep follows when "the intrinsic metabolism of all nerve elements, including those of the cortex is itself reduced."* Promotion of elimination, removal of exciting agents with reduction of blood pressure by spinal vibration with the ball vibratode, d'Arsonvalization, or prolonged body vibration (Bechterew and Tschigajew†) are indicated.

* Sajous. The Internal Secretions and the Principles of Medicine, page 1260.

† Cyriax. Vibrations and Their Effects.

Vaso-constriction and vaso-dilation* are thus explained:

"1. Vaso-dilation is due, in the case of arteries and veins, to the diminution of blood-plasma, and, therefore, of adrenoxidase, in the muscular layers of these vessels.

"2. The blood-plasma being supplied to the vascular walls by the vasa vasorum, it is through contraction of these nutrient vessels that dilation of the vessels is caused.

"3. The vasa vasorum receiving their blood-plasma from larger arterial vessels supplied with vaso-constrictor nerves it is through vaso-constriction of these vessels that the volume of blood circulating through the vasa vasorum is diminished.

"4. It is therefore by vaso-constrictor action that vaso-dilation is produced, 'vaso-dilator nerves' having no existence in fact.

"5. Vaso-dilation being caused by constriction of the nutrient arteries of a vessel, the vaso-motor nerves supplied to these nutrient vessels should not be termed 'vaso-dilators' but 'stricto-dilators.'

"6. The mechanism of vaso-dilation is that through which all exacerbations of activity in any organ, whether belonging to the alimentary, circulatory, locomotor, visual, auditory or any other system, is incited and sustained."

Impulses from the pituitary reach the peripheral vessels by way of the bulb and its vaso-motor pathways. "General contraction of all arteries result from exciting the bulbar vaso-motor center, the sympathetic vaso-motor action being limited to the arteri-

* Sajous. The Internal Secretions and the Principles of Medicine, page 1124.

oles." The sympathetic center and the bulbar vaso-motor center may be independently stimulated.* They are related through fibres of special sympathetic type:†

The *cerebral vessels*, are thought by Spina to have a spinal vaso-motor center "susceptible of reflex irritation extending to the third cervical vertebra."

WHEN CONSTRICTION OF AN ARTERY IS PRODUCED, the following effect results according to Foster in: (1) diminished flow through the artery itself; and (2) increased general arterial pressure leading to increased flow through the veins. It should be remembered that the contraction of an artery is slow and of long duration. There is also a latent period. Mechanical stimuli must not, therefore, be too continuous or too heavy unless dilatation is sought, because strong percussion induces dilatation of the blood vessel and light percussion if too prolonged has the same effect.

THE EFFECT OF DILATATION is (1) to increase the blood flow through the artery, (2) to lessen general pressure, and (3) to lessen the flow through the other arteries. Dilatation then is especially indicated in the treatment of diseased conditions associated with impaired nutrition.

VASO-MOTOR DISTURBANCES AS ANGIO-SPASM OR PARALYSES are treated by mechanical vibration or by spinal concussion (Abrams). For angio-paralyses Abrams applies concussion over the spinous process of the 7th cervical vertebra, and for angio-spasm he concusses over the spinous processes of the 9th, 10th, 11th and 12th dorsal vertebrae. The application of

* Sajous. The Internal Secretions and the Principles of Medicine, page 1203.

† Ibid. The Internal Secretions and the Principles of Medicine, page 992.

mechanical vibration to the intervertebral spaces between the 7th cervical and 1st dorsal and between the 9th and 10th, 10th and 11th, and 11th and 12th dorsal vertebrae with medium pressure will obtain the same result.

In the treatment of a case of erythromelalgia, the following may be of interest. The patient suffered in addition to other symptoms from most violent attacks of paroxysmal pain in the head,—so violent that light could not be tolerated. The eye would have to be closed to avoid a paroxysm. Noise could not then be tolerated. There was intense pain across the head and internal pain as the patient expressed it with a tendency to dyspnoea and palpitation. Intervertebral vibration between the transverse processes of the second and third dorsal vertebrae lowered the blood pressure and relieved the *internal pain*. It also had some effect on the *surface pain* but not to such a marked degree as on the internal pain. The adrenals were treated by applying the static wave current over the kidneys and light to the lower part of the abdomen and back to increase the general metabolism. The following shows the effect of a few days treatment. A rise in blood pressure (induced by auto-intoxication probably) seemed to invariably increase the severity of the paroxysms.

Nov. 3rd.		Tension	170	mm.	Pulse	70.
	After 5 minutes' vibration,	"	154	"	"	72.
Nov. 4th.		"	170	"	"	70.
	After 5 minutes' vibration,	"	160	"	"	66.
	After 4 minutes' additional vibration,	"	160	"	"	64.
Nov. 8th.		"	168	"	"	80.
	After 10 minutes' vibration,	"	150	"	"	76.
Nov. 9th.		"	152	"	"	80.
	After 7 minutes' vibration,	"	150	"	"	72.
	After 5 minutes' additional vibration,	"	146	"	"	72.

THE FUNCTIONAL ACTIVITY OF ORGANS is regulated by the "joint action of the terminals of a cranial and sympathetic nerve" (Sajous),* and as this activity involves the blood vessels the following is of interest.

"(1) That the sympathetic system does not, as now believed, carry on motor, dilator, secretory, or inhibitory functions.

"(2) That its function is purely vaso-constrictor, its field being limited to the small arteries or arterioles.

"(3) That it is entirely independent of the vasomotor system (whose action is general), being capable, unlike the latter, of influencing each organ individually.

"(4) That its terminals form part of the mechanism of all organs.

"(5) That the specific rôle of its terminal fibres is to oppose the stricto-dilators and restore the arterioles of an organ to their normal calibre when the functional activity of that organ is to cease.

"(6) That the volume of blood which circulates through any organ, whether the latter be in the passive state or functionally active, is regulated by the joint action of the motor and sympathetic centers in the posterior pituitary.

"(7) When the organ is to become functionally active, the stricto-dilators (fibres of a *cranial* motor or secretory nerve) cause its vessels to relax and to augment the volume of blood coursing through it; when its activity is to cease, the sympathetic constrictors cause the vessels to contract sufficiently to

* Sajous. The Internal Secretions and the Principles of Medicine, page 1198.

reduce the blood in transit to the volume required for adequate local nutrition."

Methods for controlling the vaso-constrictors and vaso-dilators of the organs by vibration will be considered in a following chapter. The knowledge of the action of mechanical vibration, a recognition of pathological conditions present, and an analysis of effects produced will determine how and when vibration should be applied.

The writer has observed that when A COLD is treated early by auto-condensation (d'Arsonvalization) it may be aborted. This treatment lowers blood pressure. Abrams* noted that a cold, which he considered as presenting the symptoms of an angio-paralysis, could be aborted by concussion of the spine of the 7th cervical which in many cases lowers blood pressure. For this effect the author applies mechanical vibration with the ball vibratode between the transverse processes of the 7th cervical and 1st dorsal vertebrae. Dryness of the air passages or a temporary cough may ensue. Whether a vibratory treatment between the transverse processes of the 2nd and 3rd dorsal vertebrae which often lowers blood pressure will abort a cold, is yet to be determined.

VIBRATORY FRICTION APPLIED CENTRIPETALLY to the extremities assists lymphatic and venous circulation in joint affections, oedema, dropsy, and similar conditions. For this administration the rubber-covered disc vibratode is to be preferred and the surface to be vibrated should be first dusted with talcum powder. In cases of oedema begin the frictional treatment near the trunk and gradually ap-

* Abrams. Spondylotheraphy, page 284.

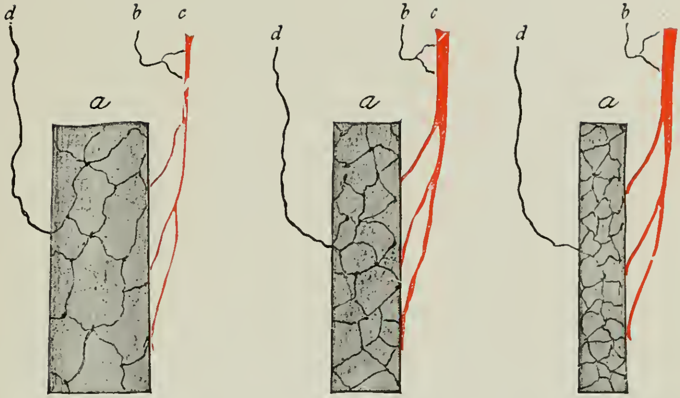

Fig. 1. *Fig. 2.* *Fig. 3.*

SCHEMA OF THE STRICTO-DILATOR (CRANIAL-MOTOR) AND SYMPATHETIC NERVES IN THEIR RELATIONS TO ORGANIC FUNCTION.
[Sajous.]

Fig. 1. DURING FUNCTION: Arteriole a dilated; stricto-dilator b active and vasa vasorum c constricted; sympathetic d passive.

Fig. 2. DURING REST, organ being kept nourished: Arteriole a semi-contracted; stricto-dilator b passive and vasa vasorum c dilated; sympathetic d active.

Fig. 3. DURING INHIBITION (excessive and therefore morbid constriction), the organ being deprived of blood: Arteriole a, lumen obliterated; stricto-dilator b passive and vasa vasorum c dilated; sympathetic d over-active.

PLATE VIII.

proach the extremities, and apply interrupted vibration about the joints. (See Chapter IV.)

Vibratory friction applied centrifugally to the extremities is indicated in deficiency of *compensatory hypertrophy* of the heart, associated with valvular lesions or pulmonary circulatory obstructions. It is also valuable in the treatment of insomnia due to congestion of the blood vessels of the head, and all other conditions where acceleration of the arterial flow is sought. If mechanical vibration be applied to the bowels, it induces a slowing of the pulse. In an experimental case the pulse was 84 before abdominal vibration and was reduced to 74 following the treatment. Mechanical vibration also affects the circulation by increasing or diminishing the blood flow.

From the effects of mechanical vibration applied as a *tissue exerciser,* it may be inferred that it increases the number of red blood corpuscles and haemoglobin. Winternitz has demonstrated that exercise increases the number of red blood corpuscles. It undoubtedly also influences phagocytosis as does manual massage by causing more leucocytes to become phagocytes and by breaking up minute adhesions coincidently increasing circulatory activity.

In the treatment of chlorosis the activity of the digestive, circulatory, and respiratory systems together with that of the nervous system should be promoted. Daily warm baths of five minutes' duration, an easily digested diet, open bowels, and regulated daily walks are insisted upon. Abdominal vibration with the disc vibratode and the ball or cap

shield as directed for constipation will stimulate the abdominal sympathetics and promote circulatory activity. It will induce a local vaso-constrictor effect and thus cause vaso-dilatation in other parts—Cyriax notes the head. Appropriate exercises, as directed by Cyriax* may be advantageously used.

SECONDARY ANAEMIA due to auto-intoxication may be successfully treated by high colonic flushings, daily baths, outdoor walking, light, the static wave current and spinal vibration of short duration for stimulation and a vibratory treatment of the abdomen, liver and spleen. Eliminate the poison and increase the metabolism.

IN PHLEBITIS mechanical vibration is sometimes of benefit. Morris reports the cure of a case, "complicated with lymphangitis and adenitis." He sought to accomplish two objects, *viz.*, "(1) improvement of the systemic condition with a possible reduction of obesity; and (2) the abatement, if not the actual cure, of the local inflammatory trouble. For the accomplishment of the first indication, deep vibration was applied to the spinal nerve centers of the liver and spleen (*Vide* Pilgrim's 'Vibration Stimulation,' 4, 5, 6, 7, 8 dorsal), and also to the organs direct, as well as over the abdominal muscles. It was hoped that this might favorably affect the local conditions."

He "sought to accomplish the second indication through stimulation with the brush (multiple point vibratode) of the lymphatics in the inguinal region and mild brush applications directly to the affected area, following the venous current throughout, supplemented by the application of the ball with medium stroke, to the lumbar and dorsal spine."

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* Cyriax. The Elements of Kellgren's Manual Treatment, page 381.

Heavy pressure must be avoided and the greatest care exercised in the employment of vibration in the treatment of phlebitis. The author prefers the use of the high candle power incandescent light and the static brush discharge which is the treatment par excellence in these cases.

The following, RELATIVE TO PAIN as it concerns the arterioles, is important in a work on mechanical vibration.

Pain is commonly due to pressure (Wm. Benham Snow) associated with stasis or tissue infiltration and exerted upon the sensory nerve terminals or nerve trunks of the nervi nervorum; and any agent which indirectly or directly causes diminution of such stasis or infiltration or removes other objects which exert pressure, counteracts pain.

To reduce the stasis causing pain, four measures may be adopted based on Sajous' findings.*

1. "Secure general vaso-dilation by depressing the vaso-motor center." Vaso-dilation is accomplished by spinal vibration between the transverse processes of the 2nd and 3rd dorsal vertebrae usually. When there is myocardial insufficiency, vibrate with the ball vibratode between the 7th cervical and 1st dorsal vertebrae.

2. Secure general constriction of the arterioles by stimulating the general sympathetic center.

3. Produce reflex constriction of peripheral arterioles including those of the painful nerves, by irritating directly the cutaneous sensory terminals. This can be accomplished by local vibration with the disc vibratode.

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* Sajous. The Internal Secretions and the Principles of Medicine, pages 1541-1542-1543.

4. "Secure depletion of perineural arterioles, and therefore of the endoneural capillaries." This probably follows local vibration, interrupted or frictional.

Spinal vibration with the ball vibratode over the spinal segment corresponding to the skin area involved is indicated in the treatment of painful areas.

Painful or tender spinal areas when not due to organic affections may be relieved by interrupted vibration with the ball vibratode applied four or five times in succession, beginning with moderate pressure and gradually increasing it, in accordance with the patient's tolerance, a moderate rate of speed and full stroke being employed. For the treatment of sensitive areas other than spinal, the same method is employed, the disc vibratode being substituted for the ball. Pain due to a diseased viscus or tissue of course will not be relieved by such measures, on the contrary it is apt to be increased.

"The thyroid and parathyroid glands" Sajous* holds "are not true glandular organs" but that they consist of a capsule, enclosing "a connective tissue reticulum forming tubular cavities lined with a basement membrane, the follicles, whose secreting cells are leucocytes (from the alimentary canal or circulation) whose granules represent the active constituents of the colloidal secretion. He believes their secretion is carried by the lymphatics and finally reaches the superior vena cava, the heart, and the pulmonary alveoli."

The nerves† to the arteries (vaso-constrictor and vaso-dilator) pass "either by way of the superior

* Sajous. The Internal Secretions and the Principles of Medicine, page 1072.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1128.

laryngeals or through the plexus often formed by the depressor with the sympathetic and vagal nerves." The "vaso-constrictors are sympathetic fibres." Constriction of the arteries lessens the blood supply and consequently the gland's functional activity is lowered. Landois thinks that THE THYROID GLAND RECEIVES ITS VASO-MOTOR nerve supply from the superior cervical ganglion of the sympathetics.*

"By increasing" Sajous believes, "the functional activity† of the thyroid and parathyroids it (the test organ which is the sensory organ in the partition between the two lobes of the pituitary body) increases, through their secretions, the sensitiveness of all cells, including bacteria, and their vulnerability to phagocytes, inasmuch as:

"The secretions of the thyroid and parathyroids jointly form the opsonin and agglutinin of the blood:

"And consequently it follows from certain assertions:

"That the adrenal system, composed of the pituitary body, the adrenals and the thyroid apparatus, constitutes the immunizing mechanism of the body."

The vaso-dilator fibres of the thyroid are from the depressor.‡ The adreno-thyroid center regulates the circulation of the anterior pituitary body and of the thyroid apparatus, by means of the "depressor nerves."|| The thyroid's depressor vaso-dilator fibres—(some of which go to the parathyroids)

* Landois. Text-Book of Human Physiology, page 763.

† Sajous. The Internal Secretions and the Principles of Medicine, page XII. Vol. II.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 1129.

|| Sajous. The Internal Secretions and the Principles of Medicine, page 1133.

"jointly constitute the thyro-parathyroid secretory nerve." Their stimulation increases its activity* because the vaso-dilation brings more leucocytes, and this is shown by an increased amount, an excess, of colloid, its secretion.

GOITRE, an enlargement of the thyroid gland, may be "vascular, cystic, or parenchymatous with colloid degeneration."

EXOPHTHALMIC GOITRE or Graves' Disease pathologically considered† "comprises a progressive hypertrophy with hyperplasia and varying degrees of infiltration of the gland, which in undisturbed cases, progress ultimately to a degree of extreme hypertrophy. The accompanying tachycardia associated with great dyspnoea is undoubtedly due to the excess of thyroid secretion thrown into the circulation, the same condition being produced by the excessive administration of thyroid extract."

The indications are, according to the same authority, "(1) to induce cessation of the process associated with increased enlargement of the gland, be it inflammatory, or due to some metabolic disturbance; (2) the coincident diminution of hypersecretion, and (3) the removal of the deformity."

Our results in the treatment of goitre, simple and exophthalmic, make another link in Sajous' chain of evidence. He believes that exophthalmic goitre is due to suprarenal overactivity, "though initiated through thyroid overactivity."‡ The X-ray treat-

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* Sajous. The Internal Secretions and the Principles of Medicine, page 1130.

† Wm. Benham Snow. Treatment of Exophthalmic Goitre and Myxoedema.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 186.

ment of the gland in conjunction with the static wave current and mechanical vibration, is a successful method. All of the writer's cases have had a coincidental menstrual disturbance which has also received local treatment. Radiant light and heat are sometimes used as an eliminant. The X-ray* "in repeated regular doses is to inhibit the tissue activity; probably by inducing contraction of the tissues with the induction of inertia in all living cells." The application of the static wave current by "inducing energetically successive contraction and relaxation, as when administered with a discharge not too rapid at the spark gap, initiates an active tissue gymnastics throughout the substance of the gland thereby forcing out all infiltration and removing as elsewhere all inflammatory action and restoring its normal metabolism" (Wm. Benham Snow). Mechanical vibration applied over the gland and the lymphatics of the axilla and neck with the disc vibratode promotes elimination and induces the removal of the glandular infiltration. With the disc vibratode, and a half stroke, apply prolonged interrupted vibration to the goitre, making the left hand a resisting surface on the other side of the gland. Vibrate first one side, and then the other, four or five times. Then use vibratory friction of the neck anteriorly and at the side, for circulatory stimulation. As a supplementary treatment to promote elimination, vibrate the axillary glands, and the liver, and spleen. Interrupted vibration with the ball vibratode in the interscapular region will lessen the pulse rate. In some cases prolonged interrupted vibration, full stroke,

* Wm. Benham Snow. Treatment of Exophthalmic Goitre and Myxoedema.

with the ball between the transverse processes of the 7th cervical and 1st dorsal vertebrae will reduce the arterial tension and indirectly affect the gland. For this purpose it should be continued for five minutes with a few periods of rest.

MYXOEDEMA is characterized by "hyperplasia of the connective tissue and mucoid infiltration of the cutis and surrounding organs. The thyroid gland also becomes atrophied, and it is probably upon the absence of the thyroid secretion that the condition depends." The lessening of the thyroid would mean according to Sajous' views on the thyroid that the vaso-constrictor fibres of the thyroid were stimulated, with consequent lowering of the metabolism; because the thyroid secretion keeps the test organ functionally efficient and "through it the adrenals," which keeps up the supply of adrenoxidase supplying oxygen to the tissues. In myxoedema the secretion being lessened there is less adrenoxidase hence less oxygen for the tissues and consequently a deficient metabolism results.

The treatment calls* for (1) to supply the deficiency from some external source (2) to induce, if possible, the functional activity of the gland and (3) to restore so far as can be, the normal metabolism and remove in adults the pronounced characteristic oedema or hardening and thickening of the skin and subcutaneous tissues found in advanced and neglected cases.

The static wave current applied with a metal electrode over the gland for twenty minutes, the spark-gap being from one to three inches, promotes meta-

* Wm. Benham Snow. Treatment of Exophthalmic Goitre and Myxoedema.

bolism and increases the activity of the gland. "The effect of the current is to remove infiltration, abate inflammation, by removing stasis and re-establishing circulation, at the same time inducing tissue activity." The static wave current is also given over the abdomen, a flat metal electrode six by eight inches, being used. Slow speed and the length of the spark-gap regulated so as not to cause tonic contraction is necessary. More recently thyroid extract has been used in connection with the treatment with marked success.

Administer general spinal vibratory treatment with the ball vibratode for its tonic effect. Do not use heavy pressure. With the patient lying in the prone position apply deep vibratory friction to the soles of the feet from the heels to the toes six or seven times, interrupted vibration about the ankle, and vibratory friction particularly to the posterior surface of the legs. Follow this with interrupted vibration to the knees and vibratory friction to the thighs. After a short rest, with the patient lying on his back, apply vibratory friction anteriorly on the legs and thighs, particularly the thighs, and interrupted vibration to the ankles, knees and inguinal glands. A vibratory treatment of the abdomen, liver, and spleen, and a stimulating vibratory treatment of short duration with half stroke and moderate speed, should follow, on each side and over the thyroid gland. The face, tongue, hands, and arms should also be vibrated as conditions indicate.

Exercises adapted to the use of the particular group of muscles involved should be given daily. A daily cold sponge is advisable each morning if the patient reacts well. Dry hot air or radiant light and

heat baths twice a week are indicated. Do not allow these patients to lead a sedentary life,—activity is necessary. Thyroid extract may be used in conjunction with vibratory treatment.

The spleen is situated "beneath the 9th, 10th, and 11th ribs, between the axillary lines—lines drawn vertically downward from the anterior and posterior margins of the axilla. Its upper edge is on a level with the spine of the 9th dorsal vertebra and its lower with the spine of the 11th." Vaso-motor fibres of the spleen come from the medulla and Landois* states pass through the spinal cord "which is said to contain between the 1st and 4th cervical vertebrae ganglionic cells that likewise influence the contraction of the spleen."

"The nerve† supply of the spleen is the general motor system (sympathetic) which supplies efferent nerves, which serve only to maintain toxic contraction of the arteries and of the trabecular muscles, thus sufficiently activating the flow of blood to the lobular compartments and to the Malpighian corpuscles to maintain their functional efficiency during the passive period, and the vagus system.

"The vagus system supplies both the sensory and motor nerves that excite and govern the functions of the organ during its active period, which begins about the fourth hour of digestion.

"When, as a result of reflex stimuli through the efferent gastroduodenal branches of the vagus, the spleen becomes functionally active, the vagus impulses impose their rhythm upon the extrinsic motor

* Landois. Text-Book of Human Physiology, page 195.

† Sajous. The Internal Secretions and the Principles of Medicine, page 390.

plexuses (extensions of the splenic plexus), and the vagus system assumes control of splenic functions. As a result,

"(a) The extrinsic arteries are constricted beyond their normal tonic calibre; the speed of the blood-flow into the organ is increased and the blood allowed to slowly accumulate therein (probably owing to restricted calibre of the venous exit), thus causing its *dilation.*

"(b) About the fourth hour of the digestive process the arterial and venous calibres are equalized and the splenic products (secretion, leucocytes, broken-down corpuscles, and pigments) are voided into the splenic vein and increased rapidly. This continues for two to four hours, when the calibres are readjusted by the vagus and the organ resumes the passive state."

Stimulation of (1) the central end of the sensory nerve; (2) of the peripheral ends of both splanchnics; (3) of the peripheral ends of both vagi, causes contraction of the spleen, as does also stimulation of the spleen itself by cold, electricity, or vibration, directly or reflexly by spinal stimulation.

For the treatment of splenic congestion deep vibratory friction or interrupted vibration with the disc vibratode should be administered over the side of the gland from the 9th to, and including the 11th rib between the axillary lines. Reflex contraction of the spleen can be induced by vibrating with the ball between the 1st and 2nd and 2nd and 3rd lumbar vertebrae following Abrams' method of vertebral concussion. The treatment should be prolonged for five, ten, or even fifteen minutes as the response warrants. The same result is obtained by the static wave cur-

rent. This is of value in malaria and pathological states characterized by an enlarged spleen.

DILATATION OF THE SPLEEN is obtained by Abrams* by concussion of the 11th dorsal spinous process.

Tenderness has been noted of the 9th and 10th dorsal nerves on the left side when the spleen was pathologically affected. The nerves have their exit between the 9th and 10th, and between the 10th and 11th dorsal vertebrae. These nerves if conditions warrant should be vibrated locally with the disc vibratode or at their sites of exit with the ball vibratode.

* Abrams. Spondylotherapy, page 352.

CHAPTER VIII

Mechanical Vibration in Relation to the Lymphatics and Respiratory System.

The lymphatics, which finally discharge their contents into the blood stream at the junction of the subclavian and internal jugular veins by means of the thoracic duct on the left, and the right lymphatic duct on the right, are remarkably influenced by vibratory stimulation, particularly so in respect to drainage and metabolism. The same is true of all lymphatic glands—those of the neck, the mesenteric, mediastinal, axillary, inguinal, popliteal, and the coeliac glands. For stimulation to greater activity of the functions of the glands, the application of interrupted mechanical vibration with moderate or deep pressure with the rubber-covered disc is very effective.

Cyriax* thinks that "The anatomical arrangements of the lymphatics in all tendons, fasciae and aponeuroses is such that the slightest pressure or stretching with subsequent relaxation promotes the onward flow of the lymph (Ludwig and Schweigger-Seidel). Centripetal vibrations must have the effect of furthering the lymph flow in these parts; they no doubt act in the same way on the lymphatics of other parts. Centrifugal running vibrations have the opposite effect. Ledermann found that vibration

* Cyriax. Vibrations and Their Effects.

materially hastened the absorption through the skin."

The lymphatic vessels, most numerous in muscle fasciae between and around the muscle in subcutaneous tissue are readily acted upon and the lymph stream directed to the outlet by vibratory friction.

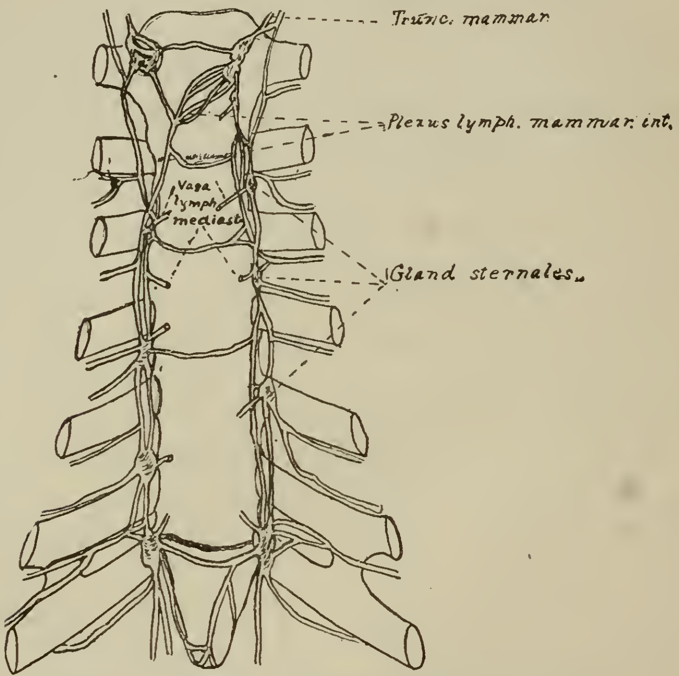

Fig. 42.—Sternal Lymphatics (after Heitzmann).

When the stroke is percussive much of "the energy conveyed by the process (percussion) is expended on the skin and its reflex and sensory powers are highly stimulated by the application." The lacteals are probably susceptible to vibration, and their metabolic processes are possibly affected. Water, peptones, glucose and soluble salts pass into the general circulation, being emptied from the hepatic vein into the inferior

vena cava. Their course is through the lymph-spaces of the villi, passing by endosmosis through the walls of the capillaries to the blood stream going through the portal vein and thence to the hepatic. The emul-

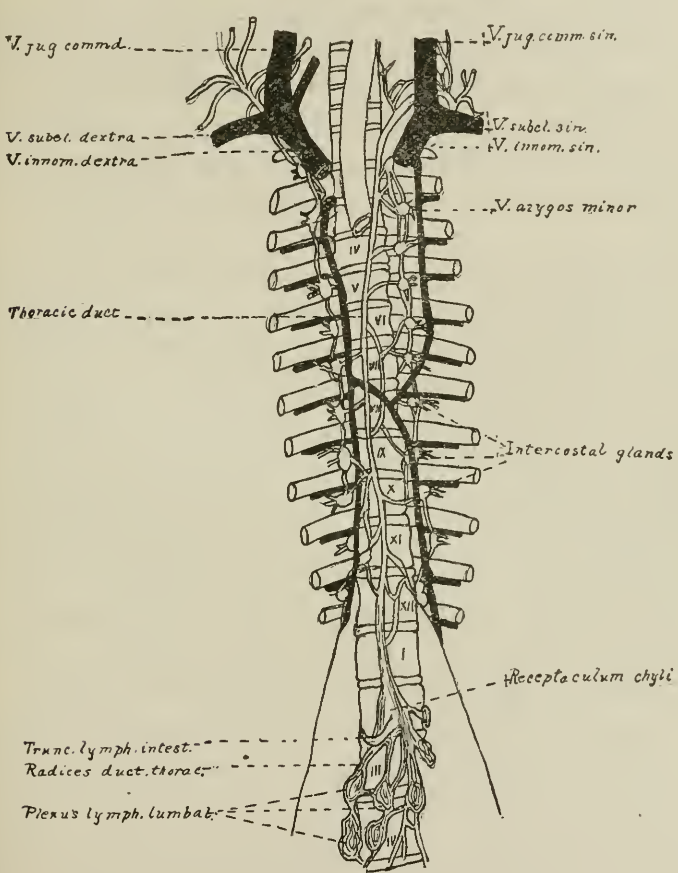

Fig. 43.—The Thoracic and Right Lymphatic Duct (after Heitzmann).

sified fat is forced from the villus by the contraction of the muscles around it on into the lacteal, and is thence carried into the general circulation through the thoracic duct. Through vibratory influences affecting the circulatory system absorption is affected,

as "absorption is less rapid the fuller and more tense the blood vessels are"—and "is the quicker the more rapid the circulation of the blood." The lymphatic circulation can be increased by interrupted vibration or vibratory friction according to the part treated for both produce tissue massage and exercise. This is of importance in treating inflammatory conditions, and enlarged glands, and in promoting absorption in cases of local œdema, dropsy and similar conditions, and also in reopening obstructed lymph channels.

The main force promoting the chyle and lymph flow depends (1) on difference in pressure in the thoracic duct and in the commencement of the lymphatic vessels, which is due to muscular contractions of the villi as before stated, aided by muscular contraction of the fibres of the vessels and by intermittent pressure arising from muscular contractions in different parts of the body. (2) Respiratory movements are important factors—inspiration increasing the flow in the veins and expiration diminishing it as well. (3) The nervous system as shown by Goltz and Hoffman also influences the flow.

Vibratory action, therefore, either impulse or friction, affecting contraction, accelerates the lymphatic circulation. While the body is at rest Reibmayr observed that the flow of lymph nearly ceased. These glands are safeguards in infectious processes and their activity is necessary in order to effect good drainage. The necessary activity may be induced by interrupted vibration or vibratory friction, varying with the part treated, each being especially applicable to different structures. To stimulate the glands of the neck employ interrupted vibration with

the rubber-covered disc vibratode and over the vessels apply vibratory friction. If the glands at the elbow are to be stimulated apply deep interrupted vibration to the axillary glands and around the shoulder joint, then apply vibratory friction centripetally to the arm. Follow this with deep interrupted vibration with moderate or deep pressure around the elbow joint. Then apply centripetal vibratory friction to the forearm, followed by deep interrupted vibration with moderate or deep pressure with the disc vibratode around the wrist joint, and employ vibratory friction from the tips of the fingers, on the dorsal surface, to the wrist, and from the tips of the fingers, on the palmar surface, to the wrist. Absorption is assisted by stimulating the lymphatics communicating with the adjacent glands.

Horvath of Keiff has discovered that bacteria reside mostly in the lymphatics; and Meltzer seems to have demonstrated that bacteria cannot withstand continued vibrations, which suggests the importance of vibration of the lymphatic glands except under some conditions when it might scatter the infection.

Sajous* observes, that the lymphatic system is poorly self-protected by lack of red blood cells, and hence of adrenoxidase. Bactericidal and antitoxic agents due to adrenal stimulants first appear in the blood to combat toxaemias, so in disease we should endeavor "to increase the proteolytic power and the aggressiveness of the phagocytes by agents which cause their digestive vacuoles to be well supplied with auto-antitoxin (their digestive triad) and to sensitize actively the bacteria." Adrenoxidase is an

* Sajous. The Internal Secretions and the Principles of Medicine, page 1795.

auto-antitoxin. Therefore we should increase the functional activity of the adrenals which should be accomplished by stimulating the upper three thoracic nerves.*

The same author notes that "the functional activity of the adrenals is increased proportionally with that of the anterior pituitary body when the latter's activity is increased from any cause. The anterior pituitary body is directly connected with the adrenals through the cervico-thoracic ganglia, the splanchnic nerves, and the semi-lunar ganglia of the sympathetic nervous system."

IN METASTATIC PROCESSES, mechanical vibration may be of value alone or in connection with other methods of treatment to relieve accompanying oedema. The surface to be vibrated should first be dusted with talcum powder. The disc vibratode should be employed, the treatment being the same as that given for *oedema.* The results of such treatment will be permanent or temporary, usually temporary, according to the pathologic process causing it.

IN CASES OF ABSCESS, open and use the vacuum apparatus of the vibrator giving a vibratory suction to empty the abscess and follow with a prolonged treatment with radiant light and heat. The condition of the patient should also be improved by regulation of hygiene, diet and exercise.

LYMPHANGITIS has been treated successfully by Cyriax† by "running vibrations (manual) to keep the process from extending toward the body, and frictions, etc., *centrifugally* down to the infected

* Sajous. The Internal Secretions and the Principles of Medicine, page 1015.

†Cyriax. The Elements of Kellgren's Manual Treatment, page 381.

focus" in connection with exercises to promote metabolism and nutrition, and to further the elimination of the toxins that have been absorbed. In the treatment of abscess of the foot with reddened areas up the leg and enlarged inguinal glands he used "suction vibrations around the abscess, and *centrifugal* running vibrations along the inflamed area down to the abscess. Vibrations over the inguinal glands and a stomach exercise were also given." The author prefers opening of the focus if pus is present and the use of hot air baths in the treatment of this condition.

ADENITIS OF A NON-INFECTIVE CHARACTER, may be treated by interrupted vibration over the nearest lymphatic glands, employing the rubber-covered disc vibratode with a stroke suited to the part and using a fairly rapid rate of speed. Prolonged interrupted vibration over the affected glands and vibratory friction of the lymphatics should follow. Treatment should be given daily at first.

In the treatment of NASAL AFFECTIONS the nervous supply of the nose must be considered. Arnold states that the vaso-constrictor neural cells of the mucous membrane of the nose are from the 2nd, 3rd, and 4th dorsal segments and that the vaso-dilator neural cells are in the nucleus of the 7th cranial. The nasal mucous membrane may be directly affected by interrupted vibration with the small cup-shaped soft rubber vibratode, shortest stroke and very light pressure, on each side of the nose on the motor points beginning near the inner angle of the eye near the root of the nose. This area should be treated about three times. Vibratory friction from the bridge of the nose downward and at the same time outward,

employing the shortest stroke and fairly rapid speed with the same soft rubber vibratode to stimulate the activity of the lymphatics follows. The hyperaemia of acute or chronic nasal catarrh is relieved by vibratory treatment as indicated above.

Attacks of HAY FEVER are sometimes relieved by mechanical vibration given as above outlined. Sajous believes that hay fever is due to "hypersensitiveness of the trigeminal center in the pituitary body—and that stricto-dilatation (the mode of action of all motor nerves) provokes muscular contraction,—the stricto-dilators regulate the flow of blood into sinuses, which thus become engorged with blood, causing the copious secretion, marked obstruction, etc., seen in hay fever."

For NASAL VIBRATION Witthauer* disinfects a vibration sound and introduces it. "Braun makes use of 2-8 per cent menthol vaseline; others wrap cotton around the sound and dip it in a solution of coçain, potassium of iodide-glycerin (1 per cent iodin) for the atrophic, and 2 per cent solution of protargol for hypertrophic conditions." In atrophic conditions the diseased parts should first be cleansed. The vibrations must be given cautiously and evenly. The time of treatment was short at first but was gradually lengthened. Witthauer treated *vaso-motoric hypertrophy* of the turbinates with a vibration-sound avoiding the alae nasi. He vibrated each side for two minutes when he began treatment. A pocket vibrator operated by a small pocket battery, a special vibratode being used, is to be preferred to the sound.

* The Journal of Physical Therapy, page 105. Text-Book on Vibration Massage with Special Reference to Gynecology. Dr. Kurt Witthauer.

NASAL CATARRH may be favorably affected by employing vibration in the nasal cavity or interrupted vibration over the motor points on each side of the nose with the cup-shaped vibratode, followed by stroking downward and outward from the bridge of the nose across the cheek. A vibratory treatment of the neck will also assist in relieving the process.

The following in respect to the NERVE SUPPLY OF THE LARYNX is of interest. The superior laryngeal nerve divides behind the hyoid bone into its two terminal branches. The external branch supplies the crico-thyroid and ramifies in the mucous membrane of the vocal cord. The internal branch supplies all of the laryngeal mucous membrane. The inferior recurrent laryngeal nerves, "the chief motor nerves of the larynx, supplying all its muscles, except the crico-thyroid, pass backwards into the furrow between the oesophagus and trachea. They ascend in this furrow and divide at the level of the crico-thyroid articulation into two branches."

IN MECHANICAL VIBRATORY TREATMENT OF CERTAIN CHRONIC AFFECTIONS OF THE LARYNX use the shortest stroke of the vibrator and the rubber-covered disc or cup-shaped vibratode. Give light interrupted vibration alternately on both sides of the thyroid cartilage.

Slow and gentle vibratory stroking or light vibratory friction centripetally when applied to the neck anteriorly and posteriorly is serviceable in *catarrhal inflammations* of the nose, pharynx and larynx as well as in *oedema* of the neck affecting respiration.

Curtis reports success in the treatment of three cases of TONSILLITIS. Application was made to the spinal nerves throughout the cervical region, using

a ball vibratode and medium stroke. The patient was then placed on his back and treatment applied to the cervical sympathetics, using a throat vibratode with firm pressure to thoroughly relax the muscles and allow the venous blood to more rapidly escape. In addition the lymphatics in the axilla were stimulated with the multiple point vibratode. Treatment was then applied to both the liver and spleen to increase the elimination of waste products.

It is well to recall that many intermittent chronic "sore throats" have their source from auto-intoxication due usually to a disordered stomach, or bowels which call for constitutional treatment and regulation of diet, the local throat treatment being of minor importance, for without the cause removed the after effects will resist unaided local treatment.

Mechanical vibration affects respiration (1) by increasing tissue combustion, and metabolism; and (2) by promoting the absorption of O and the removal of CO_2, which is induced principally by stimulation of the muscles affecting the oxidation of muscle glycogen. This also causes increased activity of the lungs, diaphragm, and all parts affected by respiratory changes, the depth of respiratory movement being increased.

Cyriax* notes that "Hasebroek and many others found that vibration improved respiration. The effect of every mechanical stimulus to ciliated epithelium is to stimulate the cilia to increased waves of movement (Kraft, Verworn, Roth). The vibrations in the lungs set up by "hackings" stimulate the lung and facilitate expectoration (Thieme, Freidlander, Erni, Cybulsky)." The same author states that

* Cyriax. Vibrations and Their Effects.

Fleisch v. Marxow thought that the heart-beat imparted shocks or vibrations that "were necessary for the gaseous interchange."

Percussion of the lungs should yield a clear, pulmonary resonance, but if the patient is stout the resonance may be less clear. The supraclavicular, infraclavicular, mammary, axillary, suprascapular

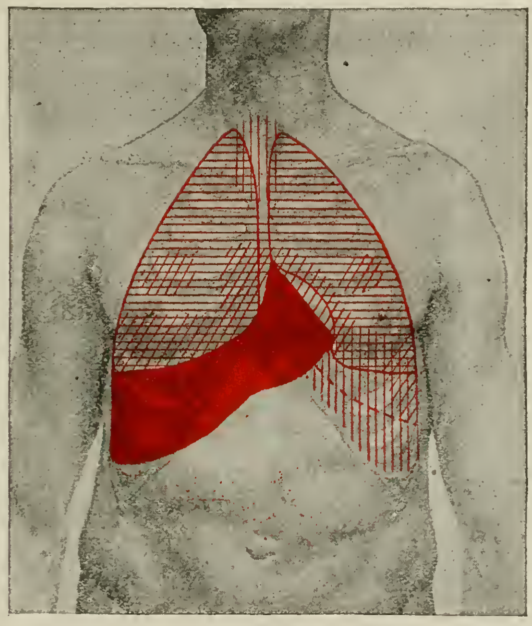

Fig. 44.—Showing the relative resonance of various portions of the anterior surface of the thorax. Horizontal lines—pulmonary resonance. Vertical lines—tympanitic resonance of trachea and stomach. Oblique lines—impaired resonance of moderate dulness due to mammary glands, liver, heart, and spleen. Solid shading—absolute dulness due to the liver and heart. (Butler's Diagnostics of Internal Medicine, D. Appleton & Co.)

and interscapular, scapular and infrascapular spaces should be percussed.

The lower border of the lung is lower than normal in emphysema and bronchial asthma, and is higher

than normal in "phthisical shrinking, collapse, a distended abdomen or paralysis of the diaphragm."

Nerve stimulation is effected relatively, as the muscles are under the control of nerves or nerve centers. If a particular intercostal nerve be cut the action of the muscle which it supplies stops absolutely, and if the spinal cord is divided below the level of the fifth cervical nerve, that is, below the origin of the roots of the phrenic nerves, costal respiration will cease but the diaphragm will still move. Gowers* states that the diaphragm is probably represented in the gray matter at the level of the phrenic nerve, the 4th cervical nerve which has its exit between the 4th and 5th cervical vertebrae. When the cord is divided below the medulla all thoracic movements cease, but the respiratory action of the nostrils and glottis does not cease. "The degree of excitability and the stimulation of the center depend upon the state of the blood, and chiefly upon the amount of blood gases, the O and CO_2 (J. Rosenthal†)."

The respiratory center may be stimulated by (1) the will, (2) directly or (3) reflexly when afferent nerves are stimulated. Stimulation of the pulmonary branches of the vagus, the auditory, the optic and cutaneous nerves affects the center reflexly resulting in increased activity, whereas stimulation of the superior laryngeal and the inferior laryngeal nerves lessens respiratory activity or causes its arrest in expiration. Both inspiratory and expiratory

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* Gowers. Diseases of the Nervous System, page 231.

† Landois and Stirling. Text Book of Human Physiology, 4th edition, page 839.

fibres are found in the vagus in the neck. Stimulation of the expiratory fibres reflexly arrests respiration during expiration. "Stimulation of the central end of the sciatic nerve usually accelerates the respiration, more rarely reflex expiratory arrest." "According to Langendorff, direct electrical, *mechanical,* or chemical stimulation of the center may arrest respiration, perhaps in consequence of the stimulus affecting the central ends of these inhibitory nerves where they enter the ganglia of the respiratory center. During the reflex inhibition of the respiration in the expiratory phase there is a suppression of the motor impulse in the inspiratory center (Wegele)." Stimulation of the nasal and ophthalmic branches of the trigeminus, glossopharyngeal, and of the olfactory stops respiration in expiration.*

Special reference has been made to these various actions relative to stimuli, as such knowledge has a direct bearing on the application of vibration and in explanation of some of the various apparent phenomena that sometimes arise from treatment.

The vaso-motors (constrictors) of the blood vessels of the lungs come from the dorsal region of the spinal cord (2nd to 7th dorsal) through the first thoracic ganglion (Brown-Sequard, Fick and Badoud, Lichtheim), which is of prime importance when spinal stimulation for such control may be necessary.

The following is a general review of the muscles of respiration from Landois and Stirling's "Text-book of Human Physiology, 4th ed.;"

* Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 845.

A. Inspiration

I. DURING ORDINARY INSPIRATION

(1) Diaphragm supplied by the phrenic nerve from the 3rd, 4th, and 5th cervical and phrenic plexus of the sympathetic, which can be reached near the right supra-renal capsule or the solar plexus. The phrenic nerve "passes behind the sterno--clavicular joint." (2) "Mm. Levatores costarum longi et breves (Rami-posteriores Nn. dorsalium). (3) Mm. intercostales externi et intercartilaginei. (Nn. intercostales)."

"According to their action, the *auxiliary muscles of forced inspiration,* are those that elevate the ribs directly or indirectly, or fix the lower jaw, so that muscles attached to the hyoid bone can act (Rutherford).

"The hyoid bone is raised by the:	Mylo-hyoid. Genio-hyoid. Stylo-hyoid. Digastric.
The sternum is raised by the:	Sterno-mastoid. Sterno-hyoid. Sterno-thyroid. Thyro-hyoid.
The upper ribs are raised by:	Scaleni. Cervicalis ascendens. Serratus posticus superior.
The shoulder girdle is raised and drawn backwards by:	Trapezius. Levator anguli scapulæ. Rhomboideus major. Rhomboideus minor.
The following muscles pull on the ribs and tend to approach them to the raised shoulder girdle.	Pectoralis major. Pectoralis minor. Subclavius. Serratus magnus."

B. Expiration

I. DURING ORDINARY EXPIRATION

"The thoracic cavity is diminished by the *weight* of the chest-wall, the *elasticity* of the lungs, costal cartilages, and abdominal wall and abdominal contents.

Ordinary expiration, therefore, is non-muscular, and the act is a purely passive one.

The abdominal contents are compressed and forced against the diaphragm by:	Obliquus externus. Obliquus internus. Transversus abdominis. Levator ani. Rectus abdominis.
The ribs are depressed by:	Rectus abdominis. Quadratus lumborum. Serratus posticus inferior. Triangularis sterni."

The data above and below are given in order that respiratory activity may be more easily controlled through appropriate nerve or muscle stimulation as indicated.

The innervation of the muscles of respiration appears to Sajous* to be as follows:

"The nervous supply of the respiratory muscles is composed of:

"A. The divisions of the general motor system are (1) the phrenic (the internal respiratory nerve of Bell), distributed to the diaphragm; (2) the intercostals, distributed to the parietes of the thorax and abdomen; and (3) the posterior thoracic (the external respiratory nerve of Bell), distributed to the serrati magni.

* Sajous. The Internal Secretions and the Principles of Medicine, page 468.

"B. The divisions of the vagal system are (1) the hypoglossal, distributed to the diaphragm (conjoined to the phrenic) and to the intercostal and external respiratory muscles (instead of sympathetic); (2) the inferior laryngeal distributed to the muscles of the larynx (except the crico-thyroid); (3) the superior laryngeal, distributed to the crico-thyroid muscle."

The control by the two systems is as follows:

"The divisions of the general motor system maintain tonic vascular contraction in, and nutrition of, the respiratory muscles, while the divisions of the vagal system incite and govern their functional and co-ordinative activity.

"The mechanical energy of the respiratory muscles is the result, as in all muscular tissues, of a chemical action of the oxidizing substance of the blood plasma upon the myosinogen of the muscle cells."

Bradford and Dean* found that PULMONARY PRESSURE is raised, and aortic pressure lowered, that is, there is pulmonary vaso-constriction, by stimulation of filaments which emerge from the cord from the 2nd to the 6th dorsal nerve. These nerves have their origin from the lower border of the spine of the 6th cervical to the lower border of the spine of the 2nd thoracic or even just below the lower border of the spine of the 5th thoracic vertebra, their exits being from between the 2nd and 3rd dorsal vertebrae to where the 6th dorsal has its exit between the 6th and 7th dorsal vertebrae. "On a level with the 3rd, 4th and 5th dorsal nerves maximum effects are obtained.

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* Sajous. The Internal Secretions and the Principles of Medicine, page 481.

The pulmonary vaso-constrictors ascend the chain up to the 1st thoracic ganglion where they become detached, to reach the pulmonary plexuses."

"The following deductions"* refer to the *nervo-vascular mechanism of the lungs and the respiratory process:*

"The nervo-vascular functional mechanism of the lungs consists of two autonomous, though correlated, systems.

"A. The respiratory nervo-vascular system which is composed of:

"(a) The pulmonary lobules, in the walls of which the blood is oxygenated.

"(b) The pulmonary artery and its subdivisions, which bring venous blood, adrenal secretion, and granules β to the capillaries of the lobules.

"(c) The pulmonary venules and veins, which return the arterialized blood to the heart.

"(d) The *general motor nerves and plexuses* (*sympathetic*) which govern the functions of the foregoing structures and the vaso-constriction of all vessels of the *pneumo-respiratory system.*

"B. The bronchial nervo-vascular system which is composed of:

"(a) The bronchial arteries, which, by their oxidizing substance, sustain functional energy and metabolism in: (I) the interlobular cellular tissue and its lymphatic vessels and glands, the blood thus used passing to the venae azygos by the bronchial veins, thence to the superior vena cava; (II) the bronchi, the terminal ramifications of which only

* Sajous. The Internal Secretions and the Principles of Medicine, page 481.

reach to the exterior of the lobules, but anastomose with the pulmonary capillaries of the latter.

"(b) *Vagal nerves and plexuses,* which supply sensation to the bronchial mucous membrane, incite and govern its secretion and the vaso-constriction of all vessels of the *bronchial system.* Vagus affects functions of bronchial tubes, etc., down to, but not including the pulmonary lobule."

The following processes are of interest to the student of physiological activities:

"1. The process through which functional energy is supplied to the lobular structures (epithelium, basement membrane, and vascular walls of the lobules) to compensate for the absence of oxygen in the blood brought to them by the pulmonary artery is as follows: The oxidizing substance in the blood of the bronchial terminal branches which anastomose with the lobular capillaries, meets the granules β contained in the blood of the latter; oxidation of the granules ensuing, functional energy is liberated, as it is elsewhere in the organism.

2. The functional oxidation process through which the right heart is supplied with mechanical energy is repeated in the pulmonary lobules, and there is some ground for the belief that the contractile effects of the adrenal secretion on the myocardium are reproduced in the pulmonary lobules, the abundant elastic fibres of the latter acting as contractile elements."

3. The respiratory interchanges that occur in the lobules represent the end-result of a complicated process for which the reader is referred to Sajous' work.

By applying interrupted vibration with moderate or fairly deep pressure with the ball vibratode be-

tween the transverse processes on each side of the spine from the 2nd cervical to the 12th dorsal and over the solar plexus, the nutritional activity of all muscles in ordinary inspiration and some of the muscles in forced inspiration is increased.

As before stated, the LUNG REFLEX OF CONTRACTION is elicited by vibrating over the spinous processes of the 4th and 5th cervical vertebrae or between their transverse processes, or directly over the lung.

When vibration is applied to the lungs directly, if the patient is lying, the arms should be extended parallel to the sides of the head, thus elevating the ribs and favoring chest expansion.

IN TREATING PULMONARY AFFECTIONS, a general vibratory massage of the chest is indicated with special directions as to specific indications. In the early stage of PHTHISIS, the blood pressure is usually high, in the later stages it is low. Concussion of 10th dorsal spine is useful in early stage (Abrams).

With the patient lying and holding his arms slightly outward and upward to straighten the pectorals without putting them on a tension, apply very light centripetal friction with the disc vibratode, going over each region about three times, from the insertion at the humerus of the pectoral muscles and from the clavicle toward the upper part of the sternum. Below the pectoral muscles work from the sternum toward the axilla following the direction of the ribs and cartilages. Avoid the breasts in women. Interrupted vibration with the rubber-covered disc is used over the chest. If there are painful spots, as are frequently found in *asthma,* use deep interrupted vibration lightly at first, gradually increasing

the pressure until the pain lessens or disappears when it is applied.

Movements may be used in connection with the vibratory treatment for assisting inspiration or expiration. If it is desirable to assist expiration, make pressure on the sides of the thorax or draw the arms upward and outward.

To help resist inspiration "Place one hand upon the abdomen, causing the patient to lift it upward by the inspiratory movement, making at the same time a degree of pressure variously adapted to the patient's condition."

Stimulating the nose and larynx causes the bronchi to contract reflexly (Landois and Stirling).

ASTHMA, SPASMODIC OR BRONCHIAL, is characterized by cough, difficulty of expectoration, and dyspnoea, the expiration being prolonged and wheezy. According to Osler, "All writers agree that there is in a majority of cases of bronchial asthma a strong neurotic element," which has been the case with all cases under the writer's care. The theories as to cause are (1) spasm of the bronchial muscles, (2) "swelling of the bronchial, mucous membrane, fluctionary hyperemia (Traube), vaso-motor turgescence (Weber), diffuse hyperemic swelling" (Clark), (3) "a special form of inflammation of the smaller bronchioles," (4) "spasm of the diaphragm or a reflex spasm of all the inspiratory muscles." Asthma may be cardiac, renal, vesical or sexual.

Salter and Bergson believe that *bronchial asthma* is due to "stimulation of the pulmonary plexus, causing spasmodic contraction of the bronchial muscle. If this condition is really spasmodic in its nature (? of the vessels), it must be usually of a reflex character; the afferent nerves may be those

of the lung, skin, or genitals (in hysteria). Perhaps however, it is due to a temporary paralysis of the pulmonary nerves (afferent), which excite the respiratory center (excito-respiratory)." Reflex asthma is due to "irritated surfaces of parts besides the lungs exciting the oversensitive vagal center."

Sajous'* explanation in respect to asthma is worthy of note. He believes bronchial asthma to be "a form of paroxysmal dyspnoea due to the concurrence of two pathogenic factors: (1) hyperexcitability of the general vagal center (2) the presence within or upon the bronchial mucosa, of endogenous or exogenous irritants as products of hypocatabolism. The mucosa requiring for the expulsion of these irritants, reflex impulses derived from the general vagal center, the hyperexcitability of the latter causes it to project unusually violent impulses, to all the elements of the bronchi, including their muscles, and these in turn being inordinately contracted, they reduce the calibre of the bronchi and thus provoke asthma." He believes an attack to be due "to vagal stricto-dilation of the bronchial arterioles" which means that the vasa vasorum of the arterioles that supply muscles (as well as any other organ), are constricted and consequently there is an arrest or diminished flow of blood to the blood vessels' walls, and therefore less nourishment is furnished which in turn causes lowered metabolism and heat in the blood vessels and consequently their spiral muscular elements relax and dilatation follows. The calibre of the bronchi is lessened "by (1) contraction of their muscles, (2) congestive swelling of the bronchial mucous membrane." The lumen may become

* Sajous. The Internal Secretions and the Principles of Medicine, page 1700.

so small that the air cannot escape from the alveoli in consequence of which the thorax and diaphragm cannot contract and cyanosis occurs. If the vasomotor center was stimulated, general vaso-constriction would follow with a resultant rise of pressure. Brodie and Dixon* confirmed experimentally "that stimulation of the vagus causes a marked diminution of the volume of air entering and leaving the corresponding lung, owing to contraction of the bronchial muscles. Kingscote* states moreover, that this procedure causes simultaneously spasmodic contraction of the diaphragmatic muscle." According to "Lefevre,† Salter, Trousseau, C. J. B. Williams, and many others, the spasmodic contraction of the bronchial muscles by greatly narrowing the calibre of the bronchi, provokes the asthma." Stricto-dilation of bronchial arterioles causes congestion of all the bronchial elements and hyperemic swelling. Sajous also notes, that researches show the absence of venous trunks in the bronchial mucosa, so it is supplied only with capillaries. In an attack these capillaries become hyperæmic. An attack is relieved by depleting them. They "can be depleted as soon as the excess of blood supplied to them is reduced." Sajous believes that "a hypersensitiveness of the vagal center in the posterior pituitary body is a predisposing cause of asthma. Poisons act on the bronchial sensory end-organs of the vagus." These cause afferent impulses which are transmitted to the vagal center. Normally they would cause "periodical contractions

* Sajous. The Internal Secretions and the Principles of Medicine, page 1702.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1703.

of the bronchi, but being hypersensitive the center projects violent stimuli to the bronchial muscles and mucosa," which causes broncho-stenosis, which in turn causes the asthma. Since broncho-stenosis is due principally to contraction of the bronchial muscles and congestive swelling of the bronchial mucous membrane, and the swelling is due to stricto-dilation of the arterioles the first indication is to contract the arterioles and lessen the quantity of blood sent to them. Constriction of the arterioles is by means of the sympathetic fibres.

Landois* says "the cervical sympathetic cord contains centripetal fibres that stimulate the vaso-motor center in the medulla oblongata." It is possible that the sympathetics are reached by vibration over the 4th and 5th cervical spines which gives temporary or permanent relief.

Pressor fibres† are represented by fibres of centripetal nerves, "irritation of which influences the vaso-motor center. They increase blood pressure. Aubert and Roever discovered pressor fibres in the cervical sympathetic."

THE TREATMENT indicated is to first control the paroxysm as by a drug stimulating the sympathetic center as belladonna which raises blood pressure and gives better oxygenation.‡ This can be accomplished by mechanical vibratory treatment so applied as to increase the vascular tension. The second indication for treatment is the removal of the cause.

The causes are local disorders or foci of irritation arising from the toxins or endotoxins of diseases fol-

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* Landois. Text-Book of Human Physiology, page 719.

† Landois. Text-Book of Human Physiology, page 764.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 1214.

lowing successively or from the constant irritation of toxic products resulting from the effects of hypocatabolism on the central neurons. Measures should be employed to care for and remove the causes as they present themselves. In the latter cases there is an excess of waste products requiring elimination. Metabolism must, therefore, be promoted by means which will awaken tissue activity, such as the application of general or local mechanical vibration or the high potential electrical currents, radiant light and heat, or by stimulating the adrenal center which may, according to Sajous, cause an increase of auto-antitoxin in the blood. Diet is of the utmost importance. A diet largely of milk is to be preferred.

The induction of the LUNG REFLEX OF CONTRACTION (Abrams) is effected by a five or ten-minute seance of interrupted vibration with the ball vibratode applied between the 4th and 5th cervical vertebrae. The patient may sit erect or lie face down during the treatment. This will relieve the rales in a remarkable manner. If conditions call for a longer vibration, it may be applied for an additional five minutes. If the rales have not then fully disappeared, an interrupted vibration over the region between the clavicle and breast and over the sternum with the disc vibratode may be applied, a half stroke and moderate speed being used. The parts are vibrated interruptedly two or three times. Abrams advises forcible concussion over any area of the lungs (by means of a plexor and pleximeter) as a method of inducing the lung reflex of contraction. When not entirely relieved, an administration of the static wave current with a small metal electrode (1 by 3 inches) covering the intervertebral space

between the 4th and 5th cervical vertebrae for fifteen minutes is often followed with good results. Blowing exercises are also practiced to advantage.

Another method is as follows: The patient first removes all clothing about the waist and chest except the undervest. Then use the ball vibratode with medium stroke for the cervical region if necessary, otherwise with full stroke and regulated pressure with a moderate rate of speed. Apply deep interrupted spinal vibration on each side alternately between the transverse processes from the 1st cervical vertebra to the waist line noting the painful sites. This application should be made to each interspace from above downward, two or three times. When sensitive spots are found, as they will be in most cases to the right of the 6th cervical vertebra, and often in the interscapular region, apply interrupted vibration for six or seven times, i.e., interruptedly each time increasing the pressure, according to the effect produced. Apply the vibratode lightly at first, gradually increasing the pressure with each application as the pain diminishes. The disc vibratode is afterwards used for applying interrupted vibration to the tense muscles of the back, then the patient is allowed to rest for a short time, after which he should lie upon his back with a pillow beneath the thorax to elevate the chest, and the arms should be extended upward along the sides of his head. Then apply vibratory friction to the neck with the rubber-covered disc vibratode, employing a short stroke.

After a few minutes' rest, apply interrupted vibration with the disc vibratode from the insertion at the humerus of the pectoral muscles toward the sternum, and below the pectorals vibrate from the sternum

to the axilla. If there are any particularly sensitive spots, apply interrupted vibration very lightly at first, gradually increasing the pressure at each impulse until the pain is lessened or disappears. Also apply interrupted vibration with the rubber-covered disc vibratode over the solar plexus to affect the phrenic nerve and thus affect the action of the diaphragm. In addition the writer sometimes applies interrupted vibration over the region of soreness, which may form a girdle around the waist line in men, or be in the abdominal region in women, probably due to their manner of breathing and mode of dress. Treatments should be given daily at first, and later the intervals may be lengthened as the condition improves. If possible, give the treatments early in the day for the comfort of the patient. Sometimes forced breathing exercises are useful while the patient lies in a prone position, the head and chest being below the level of the pelvis, to assist in getting rid of the secretion. If the patient's general condition is poor, the static wave current may be administered with advantage, employing a spinal electrode.

Theoretically the induction of THE REFLEX LUNG CONTRACTION is indicated in CHRONIC BRONCHITIS where "bronchial dilatations are not uncommon and emphysema is a constant accompaniment, in BRONCHIECTASIS when not congenital or an anomaly, in later stages of PHTHISIS," and in all conditions where there is over-expansion.

IN ACUTE BRONCHITIS, CHRONIC BRONCHITIS AND PHTHISIS PULMONUM, Cyriax* has always found an interscapular tenderness which he believes is due

* Cyriax. Elements of Kellgren's Manual Treatment, page 164.

to the posterior pulmonary plexus being "largely formed of sympathetic fibres from the second to and including the fourth thoracic sympathetic ganglia." He also often noted tenderness in the nerves supplying the intercostal spaces that lie over any affected area.

Emphysema, the most marked form of which is hypertrophic emphysema is "characterized by enlargement of the lungs due to distension of the air cells and atrophy of their walls, and clinically by imperfect aeration of the blood and more or less marked dyspnoea." The treatment should aim* to "increase the blood supplied to what normal alveoli remain, by causing dilation of the arterioles or by increasing their propulsive activity, and simultaneously the power of the blood to absorb oxygen." Hence stimulate* the sympathetic and the adrenal systems. Induce a rise of blood pressure. The treatment is practically the same as for asthma, but the prognosis is not so good.

The lung reflex of dilatation is elicited (Abrams) by concussing from the 3rd to the 8th dorsal vertebra,† or by vibrating between the transverse processes of the 3rd and 4th, 4th and 5th, 5th and 6th, 6th and 7th, 7th and 8th dorsal vertebrae, when the same effect has been produced by the writer. The effect is recognized by hyper-resonance and the "extension of the pulmonary percussion note and obliteration of the cardiac and splenic areas of dulness."‡

* Sajous. The Internal Secretions and the Principles of Medicine, page 1859.

† Abrams. Spondylotherapy, page 303.

‡ Abrams. Spondylotherapy, page 295.

Theoretically the *lung reflex of dilatation* may be employed in PULMONARY ATELECTASIS when the lessened expansion is not due to causes of obstruction or compression which are not removable as tonsillar enlargement, adenoids, growths, kypho-scoliosis.

Absorption is assisted by stimulating the lymphatics communicating with the axillary glands. To accomplish this apply vibratory friction centripetally.

"Poliakow reports most excellent results in the treatment of cases of PLEURISY WITH EXUDATION," by the employment of thoracic massage. The manipulations were made in the direction of the lymphatics of the affected region. The treatment was begun with light stroking, and soon brisk, deep massage was employed, and this was followed by percussion all consuming from ten to twenty minutes daily. Vibratory friction may be supplemented by interrupted vibration. Vibration applied to produce the vibratory effect of "hacking" is useful in UNRESOLVED PNEUMONIA, CHRONIC PLEURISY, and where there is an effusion of a serous character. According to Graham, Dr. Emil Schliegel accelerated absorption in some cases of *pleuritic effusion* by manual massage "in the form of percussion, employing only the ulnar border of the hand, striking at a rate of two blows a second, or six hundred in five minutes, which made a sitting and two of these were given daily." Properly applied vibration will accomplish the same results and with greater facility. The number of percussions per second given by Schliegel will suggest to the operator the importance of employing a definite control of speed.

CHAPTER IX

MECHANICAL VIBRATION IN RELATION TO THE MUSCULAR SYSTEM.

THE MUSCULAR SYSTEM occupies a most important position in relation to vibration, being vitally concerned in metabolism—the metabolism depending on muscle energy and circulatory activity.

In the subject under discussion the voluntary, or skeletal, muscles most directly concern us. The muscle fibres, 30 to 45 or even 120 mm. in length by 10 to 50 mm. in width, are liberally supplied with blood vessels, which are in close relation by means of capillary net works around each fibre. These are extended when the muscle is at rest, but curved when the muscle is contracted. According to Piersol, dilatations occur in the course of the blood vessels, which possibly give relief "to sudden temporary interference with the circulation during contractions." Distinct lymphatic vessels in striated muscles are limited "to the larger or looser masses of tissue of the perimysium" and are not found in many small muscles (Kolliker).

MECHANICAL VIBRATION in the author's experience has demonstrated the removal or diminution of pain, tenderness and stiffness with a consequent relaxation of the muscular tissue involved. It may by increasing circulatory activity develop an atrophied muscle, or lessen the flaccidity of a relaxed muscle. It has a marked effect on the circulation as noted in the preceding chapter, and when we recall that it is estimated that the muscles contain about 25 per cent

of the blood in the body we can understand their importance as factors in metabolism. In many cases exercise, particularly passive exercise, has been found a useful adjunct to vibratory treatment, the two acting by regulating functional cellular activity. They also assist in the elimination of toxic substances, consume reserve materials as fat, and increase nutritional activity. Mechanical vibration increases the blood supply to the muscle, renders it firmer, more healthy and more elastic. In cases following injury it rapidly diminishes the tense hardness due to local stasis so characteristic of the affected part. After the first treatment properly administered, the part treated usually has a feeling of warmth and comfort.

Vibratory effects on muscles as noted by others* are as follows: "Rood found that vibration caused contraction of muscles; this was also noted by Lavalette, but only by Mesnard whenever very rapid vibrations were used. Danilewsky found production of warmth in muscle, and Stenberg obtained reflex muscular contraction from vibration of the bony substance. Ewer states that vibrations can sometimes cause contraction in muscles which will not react to electrical stimuli."

The nerves supplying the striated muscle consist of both sensory and motor fibres, the sensory ending as a "loose network, the fibrillae of which apparently terminate between the individual muscle fibres" and the motor ending in the end-plates. There are also sensory end-plates in the tendon as studied by Golgi.† The trunk of a nerve generally enters the

* Cyriax. Vibrations and Their Effects.

† Piersol. Text-Book of Human Physiology.

muscle at its "geometric center." According to Landois and Stirling in triangular muscles, however, this point of entrance is more towards the apex of the triangle and in all muscles it is generally where the muscle substance is the *least* misplaced during contraction. The motor nerves supplying nonstriated muscles end in a ground plexus, which forms the intermediate plexus, which in turn forms the intermuscular plexus "in the cement substance between the muscle cells," which ends in the vicinity of the nucleus (Lustig) or "nucleoli of the nucleus" (Frankenhauser).

A MUSCULAR CONTRACTION* CONSISTS OF:

"1. *A period of or stage of latent stimulation* lasting from .004 to .01 second.

"2. *A period of increasing energy or contraction* (from .03 to .04), in non-striated muscles for a few seconds.

"3. *A period of decreasing energy* or more rapid relaxation (elongation) of a shorter duration than (2).

"4. *A period of slow relaxation* or the elastic after vibration."

The latent period is lessened if the *strength of the stimulus is increased,* or if heated. Cooling or fatigue will increase it. The latent period is lengthened in "secondary degeneration of the cord after apoplexy, atrophic muscular anchylosis of the limbs, muscular atrophy, progressive ataxia, and paralysis agitans of long standing, and is shortened in the contracture of senile chorea and spastic tabes (Mendelsohn)." "In chorea the curve is short." In Thomsen's dis-

* Text-Book of Human Physiology. Landois and Stirling, 4th ed., page 609.

case the contraction is lengthened. The contraction varies as the stimulus, muscle excitability being shorter for a mild stimulus or if the muscle be not fatigued. The latent period may be even from .0033 to .0025 sec. "if the muscle be still attached to the body, protected as much as possible from external influences and properly supplied with blood" state Landois and Stirling. According to the same authorities "the latency of the individual muscular elements is shorter than that of the entire muscle (Gad, Tigerstedt)."

The elongation stage varies with the stimulus, it being lengthened as the *strength of the stimulus* is increased. The fourth stage is dependent upon muscular elasticity and its time is in proportion to the force of the contraction, being longest when the contraction is more powerful. It is worthy of notice also in this connection that *"if the stimulus be applied to the motor nerve instead of to the muscle itself, the contraction is greater (Pflüger), and lasts longer (Wundt), the nearer to the spinal cord the stimulus is applied to the nerve."* It has been found by Cash and Kronecker that "individual muscles have a special form of muscle curve" which may shed some light on the value of the use of harmonic vibrations.

"The pale muscles are more excitable, have a longer latent period, are more readily fatigued, and their contraction is of shorter duration than the red." They also "produce more acid" during contraction (Gleiss) and "execute more rapid movements." "Muscles which are composed chiefly of pale fibres have a greater 'lift' and a considerably greater abso-

lute force during a single contraction, but during tetanus they are second to the red" (Grutzner). Non-striated muscles have a longer period of contraction. When a muscle contracts and also as it relaxes heat is evolved, the amount being in proportion to the muscular tension. Fatigue diminishes heat production. The above physiological data are of importance in mechanical vibratory selection for the production of certain effects.

MUSCULAR EXCITABILITY NORMALLY IS BEST MAINTAINED when the temperature of the body is normal. It varies with the rise or fall of temperature. This excitability is best induced by stimuli, although it has been demonstrated that muscles also possess "independent excitability," not depending on the excitability of nerves.* The points to which the administration of mechanical stimulation causes most energetic muscular contraction are those that best respond to the faradic current. Within natural limits the contraction of a muscle is increased by tension or extension. It is important in using vibratory stimulation that there be no interference with the blood supply as by bands, or strained positions, as it diminishes the energizing power of the muscles. Another important point concerning the regulation of the strength of interrupted mechanical vibration as applied, is to remember that although a feeble stimulus will not induce a contraction, a second one may, as "the first one has increased the muscular excitability" (Fick). Foster states that "a muscular contraction itself is essentially a translocation of molecules, a change of form, not of bulk."

* Landois and Stirling. Text-Book of Human Physiology. 4th ed., page 600.

Sajous believes that the reaction in the contractile elements of muscles when different compounds, principally hydrocarbons are oxidized, results in chemical energy which is utilized as mechanical energy by passive living voluntary muscles. When irritability is transformed into contractility by an "exacerbation of the activity of this mechanical process" active work results.

He thinks* that the chemical process to which muscular contractility is due is dependent on the oxidizing substance of the blood (of blood-plasma principally). "The nerve impulses simply exciting and governing the function." The red corpuscles carry oxygen to "sustain the plasma's efficiency as an oxidizing body."

The functional activity† of a voluntary muscle depends on

"(1) Nervous stimulus: An impulse wave transmitted from a cerebral center through motor nerves, which adjusts the muscle to a fixed degree of contraction. As the vibratory rhythm of the impulse and that of the muscle always correspond, any variation of rhythm by the brain center correspondingly modifies the muscular contraction.

"There are no independent vaso-constrictor or vaso-dilator nerves in voluntary muscles, both functions being fulfilled by the motor nerves through the filaments distributed to the muscular coat of the vessels of these muscles, and under the influence of the same impulse-wave that adjusts and fixes the latter's contraction or retraction.

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* Sajous. The Internal Secretions and the Principles of Medicine, pages 237 and 247.

† Sajous. The Internal Secretions and the Principles of Medicine, pages 261 and 262.

"In muscles* the excito-regulator branch of the general motor nerves subdivides into two branches: one of these, the 'excitor,' supplies filaments to the muscle-fibres and excites them to activity; the other, the 'intrinsic constrictor,' is distributed to the muscular arterioles that do not supply the muscular fibres with capillaries, constricts them during muscular contraction, and thus increases the blood-flow through those that do supply capillaries to the contractile elements.

"An oxidation† process in the muscular contractile elements the chemical energy of which, after conversion into mechanical energy, supplies the muscle during any stage of contraction or retraction with the power-to-do-work required to sustain either of the latter.

"This oxidation process is subject to fluctuations of activity, and occurs as the result of a reaction between two physiological compounds: first, myosinogen,—i.e., blood-plasma containing various carbohydrates and immanent in the muscle-fibre,—as a potential; second, an oxidizing substance, also contained in the blood-plasma, but in that of the arteries as reagent.

"(2) Mechanical process: Variations in the calibre of the muscular vessels give rise to corresponding variations in the proportion of oxidizing substance admitted to the myosinogen in the muscular fibre and to correspondingly marked fluctuations in the activity of the oxidation process.

"The myosinogen is stored in the contractile disks while the oxidizing plasma fills the interstitial disks,

* Sajous. The Internal Secretions and the Principles of Medicine, page 294.

† Ibid, page 262.

and an opening between the two probably exists through which the oxidizing plasma is forced when the impulse-wave adjusts the muscle to the required contraction, the quantity of energy produced being thus simultaneously adjusted to the needs of that contraction."

Mechanical vibratory stimuli may be direct or indirect. Contractions are generally best induced by the use of a ball vibratode or rubber-covered disc. Reflex contractions are not always induced by mechanical vibration. The static spark or sinusoidal current are better agents for the induction of muscular contraction unless they occur directly or reflexly through the vibration of a painful or sensitive area. If a violent stimulus be applied to a fatigued muscle a local contraction of considerable duration will result, Schiff's "idio-muscular contraction," which may also be caused "when the blunt edge of an instrument is drawn transversely over the direction of muscular fibres." The degree of contraction varies according to the *strength* of the stimulus, the *fatigue* of the muscle and the *temperature*. Schmulewitsch found by experimenting on a frog that with a "given strength of stimulus" and degree of fatigue, the contraction in the muscle of a frog was increased when heat was applied up to 35° C. but above this temperature the contraction diminished.

Mechanical vibration as a stimulus, by inducing muscular contraction, causes increased heat production, diminished elasticity, increased extensibility, and possibly a muscular sound. It increases the amount of CO_2 given off, promotes the absorption of more oxygen, and increases the production of sarcolactic acid.

If two successive stimuli be applied the effect varies. If each is capable of causing a maximal contraction, when the second follows the relaxation two maximal contractions result. If the second is applied during muscular contraction or relaxation a new contraction follows. If "both occur in the latent period, we obtain only one maximal contraction" (v. Helmholtz). If the stimuli are not maximal a summation of contractions result. Sewall believes that *the best time for the second stimulus to be applied is* 1-20 *of a second after the first.* This is important in vibratory therapeutics, for we are apt to employ too high a frequency and make too short intervals between repetitions. In accordance with these views the number of movements of the vibratode should not exceed 1,200 per minute for muscle stimulation. The number of stimuli to produce tetanus varies for different muscles. Kronecker believes that very feeble stimuli, "more than 20 per second, cause tetanus." Strong vibrations at a high rate of speed will cause tetanus. Landois wrote the letters, n, n, and every contraction was "equal to about 3.5 vibrations (of a tuning fork) (vibration =.01613 second)=.0564 second. When the right arm was tetanized 2 to 2.5 vibrations occurred=.0323 to .0403 second."

According to Landois and Stirling a simple muscular twitch caused by a single induction shock, is shorter than a momentary voluntary single movement (v. Kries), a point to be remembered in the treatment of local disease marked by *involuntary twitchings.* Kellogg employs a vibratory apparatus, having a movement of 30 per second, for inducing muscular contractions. He claims, in speaking of

mechanical vibration relative to the large and old machines, that "vibratory movements forcibly communicated to the body at the rate of six per minute, have been shown to produce at first a distinct muscular contraction with each oscillation; but if the vibration is long continued, the individual contractions become generally less distinct, and after a time merge one into another, so that the contractions become continuous or tetanic. Schäfer finds that prolonged voluntary contraction in man is an incomplete tetanus produced by eight to thirteen successive nervous impulses per second. About ten per second may be taken as the average."* Barbaker says that 2.5 to 4 stimulations per second cause a "most rapid voluntary contraction."

If "induction shocks 224 to 360 per second be applied to a muscle, the tetanus after a so-called 'initial contraction' (Bernstein) may cease (Harless, Heidenhain). This occurs most readily when the nerves are cooled. Kronecker and Stirling, however, found that stimuli following each other at greater rapidity than 24,000 per second produced tetanus;" which demonstrates that a definite *rate of speed is an important factor to be considered in the application of mechanical vibration.*

Herrman states that "the velocity of the contraction wave, in the voluntary muscles (not exercised) of a living man" is "10 to 13 metres" per second, which is diminished by conditions such as fatigue and cold; but strength of stimulus has no effect on the velocity of the wave. According to Kirke the stimuli must be very rapid or the tetanus will be

* Text-Book of Human Physiology. Landois and Stirling. page 618.

"in a condition of vibratory contraction and not of unvarying contraction."

VOLUNTARY MUSCLES RESPOND MORE QUICKLY TO STIMULI than the involuntary. If any part which is supplied with unstriped muscular fibres, e.g., the intestine or bladder, is irritated, the resulting contraction develops more slowly, extends beyond the site of stimulation, and with alternate relaxation continues for some time after the stimulus has been withdrawn. After a rectal mechanical vibratory treatment patients have said that they felt the vibratory sensation for five minutes after the withdrawal of the instrument.

"The ureters* and gall bladder are the parts least excited by stimuli; they do not act at all till the stimulus has been long applied, and then contract feebly, and to a small extent.

"The contractions of the caecum and stomach are quicker and wider spread; still quicker those of the iris, and of the urinary bladder if it be not full.

"The actions of the small and large intestines, of the vas deferens and pregnant uterus, are yet more vivid, more regular and more sustained; and they also require no more stimulus than that of varying temperatures of the air to excite them. The heart, on account, doubtless, of its striated muscle, is the quickest and most vigorous of all the muscles of organic life in contracting upon irritation."

The above principles are for a guide to the length and regulation of mechanical vibratory administrations when particular effects are sought.

PROFESSOR MAGGIORA'S EXPERIMENTS demonstrated many valuable points. He made the right and left

* Baker and Harris. Kirke's Handbook of Physiology.

middle fingers voluntarily raise six pounds every two seconds, twice in the morning, and twice in the afternoon, the fingers having been first massaged for three minutes. The left middle finger without massage raised 4,252 kilos, whereas after massage 8,019 kilos could be raised before " extreme fatigue prevented further contractions." Fatigue curves were also taken with Mosso's ergograph. The results show that massage rightly applied will increase the working energy of a muscle or group of muscles. Another experiment made was to test the effects of friction, kneading, and percussion to determine if the results had any fixed ratio of effect in respect to length of time. He demonstrated that after employing massage for varying periods of two, five, ten and fifteen minutes, that five-minute administrations produced the best result. Longer applications produced a slight difference above and below that of five minutes. The third experiment to determine the relative effects of friction, percussion and kneading demonstrated but slight difference in the work done following five minutes of friction or five minutes of percussion. The contractions representing work done were greatest in "force and duration" after kneading, but the best results were produced when the three movements alternated. The fourth experiment showed that massage temporarily restored the working power of the muscles after fasting.

From another experiment relative to the effects of massage after fatigue from an indirect cause, Dr. Douglas Graham claims that five minutes of massage equals two hours of rest.

Yet another experiment demonstrated that ten minutes of massage could restore the muscles to such

an extent that they would give a normal fatigue curve after a night's loss of sleep. He also showed that ten minutes' massage following great intellectual effort after one-half hour, left the working energy "little less than natural;" that after ten hours of fever, massage recuperated weak muscles; and that it had a favorable effect even where the blood supply was cut off.

MUSCULAR ELECTRO-EXCITABILITY may be increased by mechanical vibration. It has been demonstrated by the writer that after vibration a contraction may be induced by a smaller number of milliamperes of the continuous electrical current than before. In the case tried, a pad was held in the writer's left hand, which had not been vibrated, while make and break shocks were applied to the right thenar eminence which elicited contractions in the left wrist when nearly five milliamperes were indicated. After a vibratory treatment between three and four milliamperes caused such contractions.

FATIGUE is a condition favorably affected by vibration. La Grange* divides fatigue into local and general, immediate and consecutive fatigue, caused by "(1) Traumatic effects of work on the motor organs, (2) Auto-intoxication by the products of dissimilation, (3) Organic exhaustion through autophagy, (4) Dynamic exhaustion through expenditure of all the force at the disposal of the muscular and nervous elements." Mechanical vibratory friction employing a rubber-covered disc vibratode, as well as interrupted vibration, greatly assists in lessening fatigue.

A muscle that is fatigued has slower latent contractions, its latent period is longer, and its extensi-

* Ferdinand La Grange. Physiology of Bodily Exercise.

bility increases. Mechanical vibration also lessens stiffness, probably by removing products of dissimilation, which La Grange thinks act as an auto-intoxicant, causing the "stiffness of fatigue," and which are found among the substances which go to form deposits of *urates* (fatigue toxins). In the production of general consecutive fatigue these toxins are important factors. If resistive movements be used as an adjunct, the contracted muscle not being allowed to shorten, there is an increased metabolism. *Muscle fatigue* is relieved by promoting absorption and stimulating peripheral circulation, but *mental fatigue* by increasing the peripheral circulation of the body, thereby relieving cerebral congestion.

In regard to muscular fatigue,* Sajous remarks that adrenal overactivity is characterized by "unusual muscular metabolism and consequent muscular fatigue—also due to excessive oxidation—as manifested by the fibrillary tremor similar to that of excitement, as well as exaggerated tendon reflex due to excessive muscular and spinal oxidation" and painful cramps in the extremities. Muscular twitchings are caused by "exacerbations of adrenal activity" according to the same authority. He also believes that a small excess of thyroid secretion causes symptoms of suprarenal overactivity while a great excess causes symptoms of insufficiency. Conditions demand treatment suitable to the disease, as the removal of the muscular twitchings of chorea by proper treatment of the disease. Local twitchings are sometimes relieved by prolonged, mechanical vibration over the part involved.

* Sajous. The Internal Secretions and the Principles of Medicine, page 152.

Atrophy of the muscles when slight may be due to disuse; if considerable with the reaction of degeneration, it means "a lesion of the lower motor neurons;* if considerable, associated with no electrical reaction, "primary disease of the muscle or chronic disease of the joints is indicated."

Atrophy of the muscles should be treated by mechanical vibratory friction, centripetal, with the rubber-covered disc vibratode applied over the muscle, or vibratory rolling, for both methods increase the blood supply and improve nutrition without using up the reserve force of the muscle. The friction should be given quickly, and with but little pressure. Go over each site about three times and make the application over the entire surface three times in said manner. If atrophy is due to nerve disturbance, the nerve center should be stimulated. Appropriate passive exercises may follow and active exercises may be introduced as soon as possible.

Atrophy of the muscles associated with joint affections may be treated by spinal as well as local vibration. Kellogg so aptly states in knee involvement "the quadriceps atrophies, in hip joint cases the glutei muscles are chiefly affected, in cases of the elbow the biceps and brachialis anticus, in those of the shoulder the deltoid and supra- and infra-spinatus." In these cases the nerve segment representing the muscle or the site of the vertebral exit of the involved nerve should be vibrated with the ball vibratode or the nerve affected may be vibrated with the disc vibratode. The muscles involved are represented by the following segments, the quadriceps is represented by the 2nd and 3rd lumbar segment, the

* Butler. Diagnostics of Internal Medicine, page 509.

glutei by the 4th and 5th lumbar segments, biceps by 5th and 6th cervical segments, the brachialis anticus by the 6th and 7th cervical segments and the deltoid by the 5th, 6th and 7th cervical segments, and the supra-spinatus by the 4th and 5th cervical segments, the infra-spinatus by the 5th and 6th cervical segments. As a rule when tenderness is present it is greatest over the exits of the involved nerves, in which case give interrupted vibration over their exits with the ball vibratode.

Mechanical vibration is also indicated in the treatment of RELAXED LIGAMENTS and RELAXED AND ATROPHIED MUSCLES, such as are often present in rheumatoid arthritis and kindred affections. Vibration should be applied both above and below the affected joint in the form of light vibratory friction centripetally with a rubber-covered disc vibratode. Around the joint, however, interrupted vibration with varying degrees of pressure should be applied at first lightly and later with increased pressure. This treatment should be followed by passive, active, assistive or resistive movements according to the indications of each particular case. Time, patience, and perseverance are necessary.

TROPHIC JOINT TROUBLES are classified by Peckham* as atrophic and hypertrophic arthritis.

1. ATROPHIC is characterized by a thick, spongy, "synovial membrane full of blood," no fluctuation, with later involvement of cartilage which becomes thin and atrophic. When occurring in the knee, pressure causing a depressed patella "gives the sen-

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* The Classification and Treatment of Diseases Commonly Known as Rheumatism.

sation of stroking on rubber instead of the sharp click so easily sensed in a simple synovitis." The thickened villi may "undergo fatty degeneration or calcification. Calcified tips may break off and become floating cartilages. On account of the villous arthritis and eroded surfaces the flexor muscles of these joints may contract. The villi and erosions later cause grating and creaking. Stiffness and fibrosis may characterize the beginning of some of these cases." This type may be first noticed "in the smaller joints (fingers), later the larger joints (knees), and even the cervical vertebrae."

It has been our experience that arthritis unless infectious is due primarily to auto-intoxication and it is of extreme importance that these patients be made to realize that diet and hygiene are factors of prime import in their trouble, for although it may be palliated by local treatment, it will return with renewed force if the underlying cause is not removed. The condition of the teeth, mouth and gums should be noted and properly cared for. A diet, devoid of auto-intoxicating foods as milk, curdled milk, whey, buttermilk, koumiss, kefir, zoolak, fresh cream cheese, the carbohydrates, the farinaceous foods as rice, farina, cooked vegetables, purees, cooked fruits and toast with little butter is demanded. Later fresh fruit devoid of skins is permitted. In severe cases, a diet of one or two of the following: milk, curdled milk, whey, buttermilk, koumiss, zoolak and six slices of toast or dry or old bread a day, or zweiback is advised. Gradually cooked fruit and purees, are allowed. High colonic flushings are given daily at first and later when indicated.

In these cases promote metabolism. Physical measures* form the treatment par excellence in joint troubles. They include light from a 500 candle power lamp, or light baths, hot air, static wave current, static sparks, d'Arsonval current, and mechanical vibration. Mechanical vibration is used as follows: Spinal vibration with the ball vibratode between the transverse processes for from five to ten seconds or twelve seconds for stimulation, but prolonged spinal vibration to relieve tension should be administered over the exits of involved nerves. This vibratory treatment should be for five minutes over indicated sites. Mechanical vibration with the disc over the liver, anteriorly and posteriorly, and over the stomach and abdomen is also indicated to promote elimination. Prolonged local vibration with the disc over the affected joints and interrupted vibratory treatment over the tense muscles is also given. "If villous arthritis is present," Peckham states "the hard ball is a very efficient means of causing a contraction and slow disappearance of the condition" but the author prefers the rubber-covered disc vibratode for such treatment.

2. The hypertrophic type of arthritis is characterized by infiltration of the soft structures "later by overgrowth of bone or cartilage usually at the edges of the articular surface." Actual hypertrophy occurs still later. It may attack the spine causing pain on motion. Before the stage of the deposition of bone salts, the prognosis is favorable for cure. The 500 candle power incandescent light, the static wave current with fitted metal electrode, sparks,

* Wm. Benham Snow. Currents of High Potential of High and Other Frequencies, also the Therapeutics of Radiant Light and Heat and Convective Heat.

d'Arsonvalization, and mechanical vibration are employed. This type of arthritis is due to auto-infection or auto-intoxication that calls for elimination and circulatory stimulation, consequently not only a local treatment is demanded, but the alimentary tract should be treated. The liver should also receive vibratory treatment which helps the circulation, and the abdominal treatment stimulates the bowels and the promotion of the activity of the bowels lessens the danger of toxemia. The quantity of poisonous gases is also diminished. High colonic flushings are in order. Watch the urine for indican and urates.

In treating infectious arthritis baking of the joint is indicated before vibrating the affected joint. The d'Arsonval current is also recommended. Auto-intoxication and auto-infection and its cause should be considered and treated, and if a gonorrheal urethritis be present it should receive proper attention as outlined by Dr. Wm. B. Snow.* In regard to vibration, Peckham† says, "The hard ball on the spine stimulates the nerve centers. The soft brush (multiple point vibratode). on the stomach and intestines and the hard ball on the abdominal lymphatics stimulate all these organs. Let me also reiterate that the liver is an extremely important organ standing between the intestines and the general circulation to filter out the poisons. This is stimulated in a wonderful way by the soft brush over the liver area, front and back. This also stimulates the flow of bile. It is truly remarkable at times to see indigestion

* Wm. Benham Snow. Currents of High Potential of High and Other Frequencies, page. 151.

† The Classification and Treatment of Disease Commonly Known as Rheumatism, page 54.

of both stomach and intestines which have been treated with no benefit by the best of medical men in probably the most careful (drug) manner slowly yield and get entirely well and also the joint trouble improve "pari passu." Stimulation applied in this manner results in an increased tone to the muscular walls of stomach and intestines and this in taking up of the slack to a certain extent and a stronger muscular activity in the digestive movements. The various fluids are also in this way stimulated so that they are secreted more copiously and more rapidly. In this way it is fairly easy to understand how a better and better "tone" is obtained and how a more and more physiological digestion takes place. Hence it *must* also result in a diminution even to complete disappearance of fermentation and formation of bacteria and toxines. In cases where constipation is a serious factor in the backing up of the intestinal stream, although drugs may be used to produce evacuations, the thing to be desired is to get the tone of the muscular walls so improved that they work once again from the stimuli which are provided in nature's own way. This being the cause and the cause thus removed, the consequent joint trouble *must* disappear. All of this takes time,—in many cases, months. And at the same time that the treatment is begun, the joints themselves must receive attention in order to cause the swollen tissues (infiltration) to become contracted and restored to a normal physiological condition. Elimination must also be promoted."

PROGRESSIVE MUSCULAR ATROPHY may be benefited by mechanical vibration applied as massage, but it

must be begun early and great patience is necessary. Static electricity as a general tonic is also indicated in these cases. Blood pressure should be regulated.

PARALYSIS may be treated by vibratory friction. It has a soothing effect, and at the same time improves the nutrition of the affected muscles and prevents atrophy. Appropriate passive with a few active exercises are beneficial adjuncts. Blood pressure should be lowered and elimination promoted.

PSEUDO-HYPERTROPHY characterized by an increase in size but a lessening of power must be distinguished from hypertrophy represented by an increase in size and strength caused by use. In pseudo-hypertrophy of the muscles, "a chronic myositis" accompanied by interstitial hyperplasia of the connective tissue, the early use of vibration and hydrotherapy is indicated.

IN MYOSITIS, whether traumatic or spontaneous mechanical vibratory treatment is applicable. In fibrous or interstitial myositis "where proliferation and induration of the connective tissues have taken place with secondary atrophy of muscular fibres and consequent interference with motion, circulation, and innervation," interrupted vibration may be successfully used, observing the principles governing the relief of inflammatory conditions. Its effects are to relieve local stasis, promote absorption, induce a freer circulation, and relieve pain. If the myositis is not traumatic, elimination should be promoted by the use of light baths, and colonic flushings. A restricted non auto-intoxicating diet is essential.

IN CHRONIC MYOSITIS characterized by indurations within the bodies of the muscles, causing pains in the neck, and interference with motion, circulation, and innervation associated with indurative headache,

Abrams* effects a cure with vibration and galvano-therapy although he prefers massage. The author uses prolonged vibration with the disc vibratode with few interruptions over the sites for five minutes at a time. Interrupted vibration is then given over the

Fig. 45.—Sites of Induration. (After Abrams' Spondylotherapy. Philopolis press.)

muscles affected. With the ball vibratode interrupted vibration is applied over the segment or segments representing the muscles, or over the sites of the vertebral exits of the nerves supplying them, in each case the ball being placed between the transverse processes of the vertebrae.

*Abrams. Spondylotherapy, page 90.

INDURATED MUSCLES are most often found in the neck or head. The cause seems to be exposure, injuries, strains, infections, or adenitis. Prolonged interrupted vibration with the rubber-covered disc vibratode and ball as indicated above is employed. The static wave current applied with a metal electrode fitted over the surface for twenty minutes and static sparks are beneficial.

THE TONE OF A MUSCLE is increased by vibratory treatment, centripetal friction with the disc vibratode, and special vibration of the segment representing the affected muscle, or over the site of exit of the involved nerve alternately on each side of the spine with the ball vibratode. Much must not be expected where there is an abnormal laxness or flaccidity, usually with atrophy of paralyzed muscles denoting lesions involving the lower neurons. For testing the motor power the reader is referred to Butler's Diagnostics of Internal Medicine.

MUSCULAR RELAXATION, due to atony, is effectively treated by mechanical vibration and exercise. In such cases, centripetal vibratory friction is applied below and above the origin and insertion of the muscle as well as over it. The application of interrupted vibration with light or moderate pressure with the rubber-covered disc at the joints involved, will also assist in improving the general tone. The distal part is treated first. In these cases mechanical vibratory applications with moderate pressure should be made to the nerve centers as well.

MUSCULAR WEAKNESS may be found in insufficiency of the adrenals or in intoxication from venoma, and vegetable and mineral poisons. The cause should be

removed, elimination promoted by light baths and static electricity, and as otherwise indicated. The low blood pressure calls for mechanical vibration to raise it, and the weak heart should be stimulated. Locally the muscles may be vibrated with the disc vibratode, centripetal friction being used to promote the blood flow.

MUSCULAR CONTRACTIONS are relieved by mechanical vibration applied to the joints affording attachments for the involved muscles, with vibratory compression over the contraction in combination with appropriate exercises. Static sparks are useful.

Spinal vibration over the source of the nerve supply of the affected muscles often lessens the contraction. The vibration should be given with the ball vibratode for five or ten minutes alternately on each side of the spine over the vertebral exit or origin if necessary of the nerve involved with a few intervals of rest, moderate but firm pressure being used. But little can be expected other than to affect the blood supply in cases where there is "an increased tonus usually without atrophy of muscles paralyzed so far as voluntary effort is concerned," which is significant of disease of the upper neurons.

CONTRACTURES, "tonic muscular spasms of long standing, may be functional,—disappearing during sleep as in hysteria,—or organic characterized by not being affected by sleep, as in haemiplegia. Contractures when functional may be treated by prolonged local vibration with the disc vibratode over the affected muscles and by spinal vibration with the ball vibratode between the vertebrae of the segments representing the muscles involved or over the site of exit of the affected nerve. Sherrington demonstrated

that by exciting its antagonistic muscle, the tonus of a voluntary muscle can be inhibited. If this method is used in treating contractures use the disc vibratode over the antagonistic muscle or use the ball vibratode in the intervertebral space corresponding to the segment representing the antagonistic muscle or over the exit of the nerve involved. The X-ray is of value in treating contractures following burns.

In treating scoliosis the cause should be sought and treated. A thorough examination of the different organs locally should be made for diseased organs sometimes affect the spine reflexly. Employ interrupted vibratory pressure with the ball on opposite sides of the spine, using deeper pressure on the side where the contractions are. If necessary the nerve segments representing the contracted muscles or over the vertebral exits of the involved nerves may be given prolonged interrupted vibration with the ball vibratode. *Inhibit* the contracted, and *stimulate* the relaxed muscles by interrupted vibration with the rubber-covered disc vibratode. Carefully graded suitable exercises should follow. Trunk stretching may be combined with short vibratory interruptions over the weak muscles on the convex side. In some cases Abbott's method of straightening the spine is of great value. These cases require a devotion of considerable patience and time, both to the treatment and exercise; for such exercises must be carefully directed and suited to the requirements of each case.

Where the muscular system is affected in diseases of the nervous system, mechanical vibration oftentimes will be most effectively applied in combination with the auxiliary forms of treatment. If the affection be such that the part under treatment

has no power of motion, use passive motion as an adjunct. If there be slight but not complete motion use assistive movements. If there be a superfluity of muscular force, as in spasmodic conditions, employ resistive movements, but not forcibly. If stimulation of sensation, motion or circulation is necessary, employ interrupted vibration.

Spasmodic affections, as chorea, blepharo-spasm, wry-neck and abdominal muscular spasms, some of which are of nervous origin and are considered in the chapter devoted to the nervous system, are greatly relieved by vibration alone, or vibration in combination with corrected diet, hygiene, exercise, light, or electricity, particularly static electricity. Spasms of the muscles near the spine may be connected with visceral affections. A peripheral spasm may be independent of a spinal spasm. The two are more apt to be found together when the affection is of long standing.

Wry neck, a tonic or clonic spasm of the muscles of the neck usually characterized by a "tonic contraction of the flexors of the head" may be greatly benefited by the application of interrupted vibration. If the head moves "with each clonic spasm," the branch of the spinal accessory nerve which supplies the sterno-mastoid muscle is affected. The sterno-mastoid and trapezius are represented in the medulla, second, third and fourth cervical segments. "In spasms of the trapezius the head is drawn backward and to the side. Stimulation of the outer branch of the spinal accessory (which communicates with the first and sometimes with the second cervical nerves) causes tonic or clonic spasms of the above named muscles (sterno-mastoid and trapezius) usually on

one side." Butler believes that the third cervical nerve is most apt to be involved when the upper cervical nerves are affected.

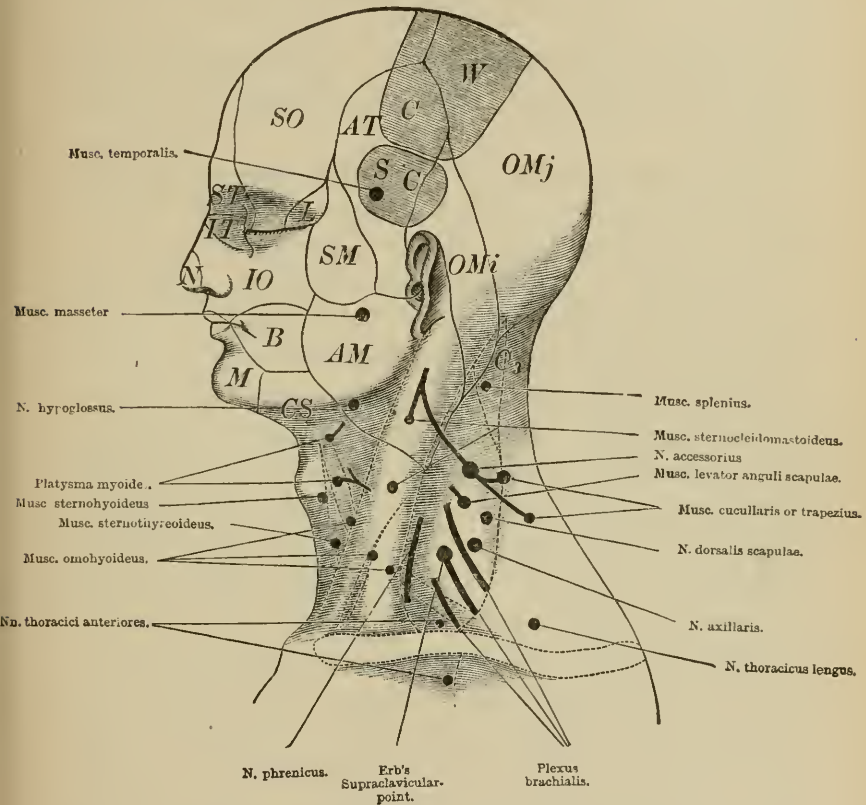

Fig. 46.—Distribution of the Sensory Nerves of the Head, together with the Situation of the Motor Points on the neck.

SO, Distribution of the supraorbital nerve; ST, supratrochlear nerve; IT, infratrochlear nerve; L, lacrimal nerve; N, ethmoid nerve; IO, infraorbital nerve; B, buccinator nerve; SM, subcutaneous malar nerve; AT, auriculo-temporal nerve; AM, great auricular nerve; OMj, greater occipital nerve; OMi, lesser occipital nerve; C_3, third cervical nerve; CS, cutaneous branches of the cervical nerves; CW, situation of the central convolutions of the cerebral hemisphere; SC, situation of the speech-center (third frontal convolution). (Landois' Text-Book of Human Physiology, P. Blakiston's Son & Co.)

Wry neck or torticollis may be:

1. Congenital characterized by a drawing of the neck to one side and absence of spasm.

2. Symptomatic characterized by tenderness and pain.

3. Pseudo characterized by real or pseudo-spasm of the neck muscles, spinal caries being the common cause.

4. Spasmodic which is of nervous origin, the upper cervical nerves or spinal accessory being involved. This may be due to a sudden chilling.

A twisting of the head associated with contracture of the sterno-mastoid or of other groups of muscles concerned in the maintenance of the head in an erect position may produce a symptomatic* torticollis.

The causes of torticollis may also be inflammation of the cervical or mediastinal glands, carious teeth, suppurating middle ear, pediculi capitis, ocular defects, facial asymmetry, congenital contracture of the sterno-mastoids, vertebral disease, local syphilis, or tumors of the neck.

The treatment should be directed first to the removal or palliation of the cause. The fourth class as classified above, is sometimes amenable to vibratory treatment. A very severe case that I had the pleasure of curing was of this type. It was caused by sitting by an open window all night. The arms were even jerked up spasmodically, so severe were the spasms.

The method of treatment consists of the application of interrupted vibration on each side of the upper portion of the spine employing the ball vibra-

* Goldthwait, Painter and Osgood. Diseases of the Bones and Joints, page 50.

tode in the interspaces from the occiput as low as the insertion of the trapezius. Notice which points elicit muscular spasm and apply prolonged interrupted vibration with the ball vibratode to such parts. It may be found necessary, if the spasm is not sufficiently controlled, to apply prolonged interrupted vibration over the involved muscles with the rubber-covered disc vibratode. With a fair rate of speed and a stroke adapted to the parts treated apply interrupted vibration over the painful sites and over the motor points of the affected muscles of the neck. In these cases painful spots are often found in the vicinity of the sixth and seventh cervical and first few upper dorsal vertebrae, as well as in the region of the first and second cervical. Movements are often a useful adjunct to vibration. Mitchell's* movements which are as follows are recommended: "The ordinary movements of rotation, forward bending, and extension of the head are the needed procedures. These are opposed by the attendant, who stands in front or behind the seated patient and places his hands on the sides of the head or clasps them over the frontal region, according to the action to be resisted, whether rotation or forward bending. In attempting extension of the neck, which perhaps would be better described as simple elongation of the neck, the patient's effort is, while keeping the chin level or a little drawn in, to elevate the head as if he were trying to make himself taller. Lateral bending of the head without rotation may be needed in certain cases (which the writer has found to be extremely useful as a passive and later as an active exercise). The face must be kept directed forward,

* Cohen's System of Physiologic Therapeutics.

while the effort is made to bring the cheek down to the shoulder; and the attendant opposes either the depression or the return of the head according to the effect sought for." Each movement should be repeated three to seven or even ten times, morning and evening, the number of repeated movements depending on the indications of the case, muscular irritability and fatigue. Passive movements followed by active ones may be directed instead of the resistive movements.

Localized muscular spasms, cramps, usually affecting the muscles of the calf of the leg, are best treated by prolonged mechanical vibration with the disc vibratode over the motor points of the affected muscles. The interruptions should be few. Care must be exercised that phlebitis is not the cause of the trouble, when the use of the 500 candle power incandescent light and the static brush discharge is indicated.

Luxations are best treated by the static wave current and the static brush discharge. The result is the relief of pain and diminution of swelling, a rendering of the tissues soft which were tense and the gradual removal of ecchymoses, and prevention of stiffness and the consequent atrophy of disuse. Mechanical vibratory treatment with the disc vibratode as an auxiliary measure assists in the prevention of stiffness and atrophy. The combined treatment is very satisfactory. Adapted and regulated movements may also be employed. Mechanical vibration applied to a joint increases circulatory activity in the structures and lessens local stasis. If vibratory friction be also applied centripetally above the joint the circulatory flow will be assisted. If vibratory

friction is applied above and below the joint, the flow of blood will be lessened in the joint, and increased in the other parts vibrated. The shoulder and hip joints, owing to their inaccessible relations, are the most difficult to treat. Dr. John Hilton has very aptly summarized the nervous supply of joint structures as follows: "The same trunks of nerves whose branches supply the groups of muscles moving a joint furnish also a distribution of nerves to the skin over the insertion of the same muscles, and the interior of the joint receives its nerves from the same source. This implies an accurate and consentaneous physiological harmony in these various co-operating structures." Vibrate the segment affected.

A SPRAIN OR SWOLLEN AND PAINFUL JOINT is best treated by the static wave current and the static brush discharge as outlined by Snow* but if these measures are not at hand and mechanical vibration is used the method of treatment is as follows: Employ vibratory stroking centripetally above the joint, gradually beginning the strokes nearer and nearer to the joint. Great care must be taken not to injure the tissues. At first also use centrifugal stroking over the tissues beyond the joint in each case. After applying vibratory friction with a rubber-covered disc vibratode above and below the joint, use superficial interrupted vibration on the joint. Day by day as conditions warrant the vibrations may be gradually increased in strength, the pressure being slightly more. Gentleness must always be exercised. If the joint is very sensitive, derivative vibration should be used, the affected joint being gradually approached,

* Wm. Benham Snow. Currents of High Potential of High and Other Frequencies, page 111.

day by day. In this manner, local stasis and compression of vessels due to exudates may be relieved by promoting elimination of the exudates.

The following movements, which have been successfully used by Graham, are suggested. When no contraindications exist "in order to gradually increase the strength of the muscles, as well as the confidence of the patient to use them, there is nothing better than resistive motion, alternately resisting flexion and extension or other natural movements of the affected joint, *while keeping the resistance less than the strength of the contracting muscles,* so that the patient may not recognize any weakness." Mechanical vibration may be used simultaneously with passive movements, combined with traction. These movements should be given slowly and as the patient forcibly exhales air from the lungs. Absolute rest should be prohibited. The patient should be encouraged to use the joint after the first treatment, a Crepe Velpeau bandage or one of similar make is recommended for the support of the joint and the comfort of the patient in the earlier stages of the treatment.

FLABBINESS OF THE MUSCLES AND A RELAXED JOINT with no marked symptoms may be treated by applying deep interrupted vibration with varying degrees of pressure around the joint and vibratory friction with a rubber-covered disc vibratode *centripetally* above and below the joint. Then use active movements, followed by proper bandaging of the joint. Resistive movements may also be found valuable, but care must be exercised that resistive motion is not carried so far as to cause fatigue.

IN CASES OF PERIARTICULAR AND CAPSULAR INDURATION AND THICKENING use deep interrupted vibration

with a rubber-covered disc vibratode to the joint and vibratory stroking, followed by vibratory friction centripetally above and below the joint, particularly in conjunction with passive movements. Tense muscles call for prolonged vibration with the disc vibratode.

"Massage,"* and better still mechanical vibration, "*disintegrates newly-formed granulation tissue,* removes the stasis which it has occasioned and presses the white corpuscles and transuded plasma into the lymph current: at the same time the newly-formed capillaries that feed this granulation tissue are ruptured and undergo retrograde metamorphosis, as well as the crushed mass, and thus the formation of connective tissue, and the subsequent change of this into cicatricial tissue which often causes pernicious retraction, is prevented or limited."

Hyperplastic tissue, firmly organized and solid, like India rubber, and not sensitive to pressure, is probably non-vascular, owing to its pressure upon and obliteration of the blood vessels which formerly nourished it. Dr. Graham regards the treatment of hyperplastic tissues unfavorably, but Billroth, Gottlieb and others claim that by "vigorous perseverance in manipulation, impervious blood- and lymph-vessels may be reopened and absorption of the adventitious tissue promoted." Mechanical vibration, like massage, is contraindicated when solutions of continuity or anchylosis are present, or where there is danger of scattering infection.

Peri-arthritis, particularly of the shoulder-joint, "a subacute or chronic inflammation of the subacromial bursa and of the loose areolar tissue under

* Graham. Reference Handbook of the Medical Sciences, vol. IV.

the deltoid, with thickening and the formation of adhesions'' resulting in or associated with neuritis with muscular spasm and limited motion, and also sometimes complicated with myositis, may be advan-

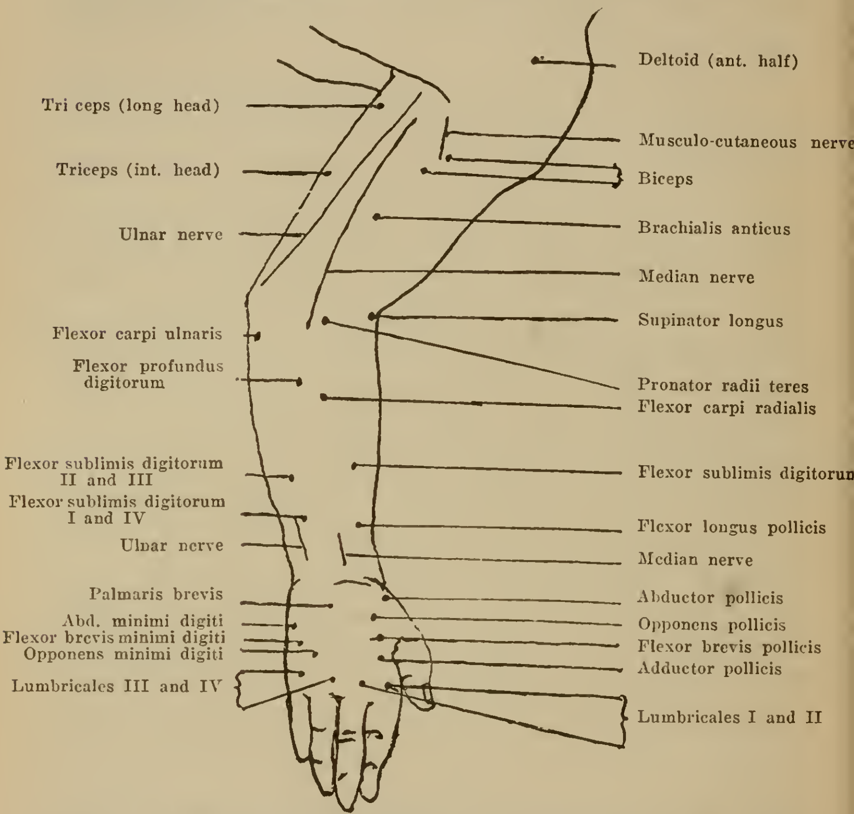

Fig. 47.—Motor points of the median and ulnar nerves and the muscles they supply. (After Landois and Stirling.)

tageously treated by the static wave current, static sparks, mechanical vibration and applied movements.

Mechanical vibration of the shoulder joint should include a spinal vibration with the ball vibratode applied between the vertebrae where the nerves representing the affected muscles have their exits as

well as over their sites of origin. Sometimes the inferior part of the trapezius muscle is contracted, in which case spinal vibration with the ball vibratode should also be applied in the intervertebral spaces

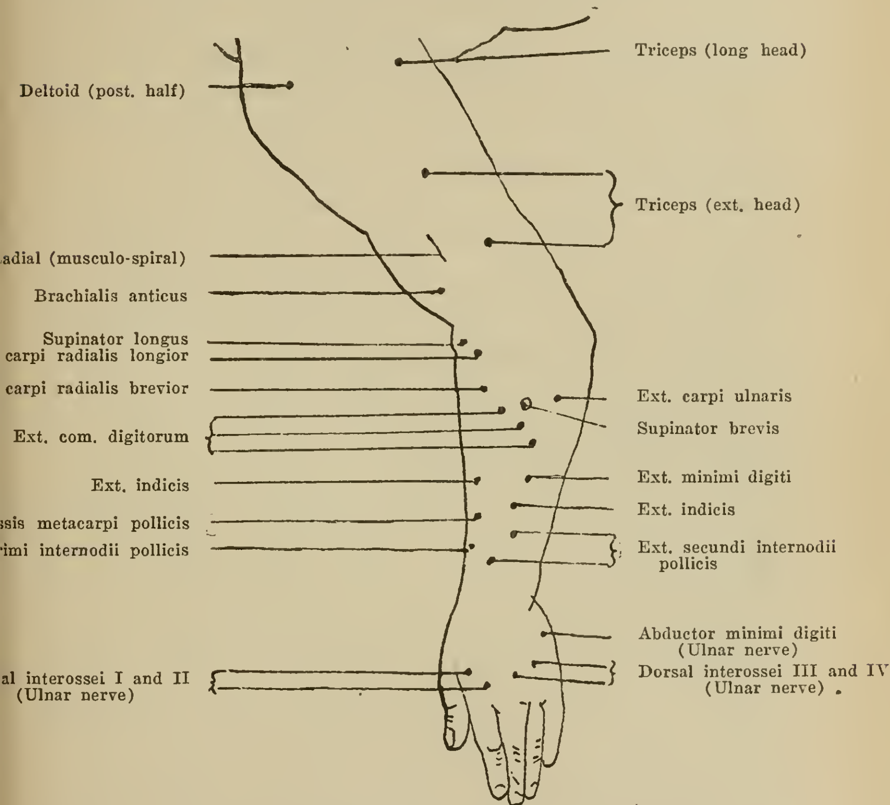

Fig. 48.—Motor points of the radial nerve and muscles it supplies. (After Landois and Stirling.)

of the lower dorsal region. Spinal vibration when employed to overcome muscular tension should be continued for five minutes or longer with one or two short intervals of rest. The trapezius for example, is supplied by the spinal accessory represented in the medulla and 2nd, 3rd and 4th cervical segments.

These nerves have their exits between the posterior arch of the atlas and the lamina of the axis, and between the 2nd and 3rd cervical vertebrae. Interrupted vibration using the disc vibratode may be applied over the motor points of the involved muscles when necessary. Attention must also be given to the muscles of the upper part of the arm as the triceps and the deltoid. A most useful exercise in cases where there is difficulty in elevating the arm is to direct the patient to stand with both shoulders against the wall, and then the well arm should be raised until it is against the wall horizontally. The attendant with one hand on the affected shoulder to prevent it from rising, should support the arm of the affected side at the elbow and gradually raise it and simultaneously bear the forearm back to the wall to correspond as nearly as possible to the position of the well arm. This should be as far as the nurse is able to move it within the limits of the patient's endurance. The arm should be so held until the nurse counts ten or fifteen, or twenty, according to the patient's strength. If the patient exhales air from the lungs as the arm is raised, the pain is lessened. A second exercise includes shoulder lifting or circling with arms down, the shoulder being brought forward, upward, backward and to the initial position. Passive motion in early cases should soon be followed by active movements. In chronic cases, break up the adhesions under an anaesthetic, and treat the condition the same as a sprain or fracture, using vibratory treatment with the static current and sparks. In using passive motion care should be taken that it is done very slowly and cau-

tiously. Painful movements are best performed during deep exhalations. X-ray is used for adhesions.

Rheumatoid arthritis first demands an inquiry into the cause which is usually auto-intoxication associated with constipation and intestinal putrefaction. High colonic flushings, daily at first, and later at intervals, are indicated with a restricted diet, limited principally to milk, buttermilk, zoolak, koumiss, toast and purees. Later stewed or fresh fruits devoid of skins, and vegetables, except onions and cabbage, are allowed, animal food being excluded.

Rheumatoid arthritis is best treated by radiant light and heat and the static modalities,*—the wave current and sparks, in conjunction with mechanical vibration. On days when light baths are not given hot or warm baths of five minutes' duration should be taken by the patient, preferably in the mornings. In these baths Epsom salt may be used two or three times a week. About two or three pounds of the salt should be used for twelve gallons of water. The patient should be told to gently bathe the parts constantly while in the water to prevent a stickiness of the skin which sometimes occurs, causing a rash. A sponge-off with warm water should follow. These salt baths may be of ten or fifteen minutes' duration. A local bath, in which is Epsom salt, of an ankle or knee is often beneficial. The additional use of dry hot air is also often of benefit. The combined method increases nutrition and the activity of the metabolic processes and removes pathological obstructions,—which are the local indications in rheumatoid arthritis. Sometimes when the deformities cannot be

* Wm. Benham Snow. Currents of High Potential of High and Other Frequencies.

removed the soft structures may be made to accommodate themselves to the changed condition. The writer has followed this line of treatment in connection with the static treatment with marked results.

Examine for spinal tenderness applying the ball vibratode on each side of the spine alternately. The sites of tenderness usually correspond to the segments representing muscles, rendered tense by the joint involvement, or to the exits of the nerves of the affected muscles. These painful sites should be vibrated with the ball vibratode for a number of minutes, it sometimes requiring five minutes to lessen the tension or contraction. If the neck muscles are involved, vibrate especially between the 2nd and 3rd cervical vertebrae to affect the third cervical nerve. Above and below the affected joints of the extremities employ deep interrupted vibration as well as about and on the affected joints, with stimulation of the next set of lymphatic glands nearest the trunk preferably with the rubber-covered disc vibratode. The tense muscles about the joint should receive prolonged interrupted vibration with the disc vibratode. If the hand is affected, the treatment is the same as for stiffness of the hand and the muscles of the arm and forearm as well as of the elbow joint should be vibrated. In the beginning cases, mild interrupted vibrations of long duration with a rubber-covered disc or cup-shaped vibratode applied over affected joints of the hand, it being closed, and over the wrist and forearm and elbow joint afford considerable relief by relieving the muscular tension. Care must be taken to steady the vibratode in order to avoid too great friction on the skin. Passive clos-

ing of the hand should be followed by prolonged active closing with short active opening of the hand. If the knee is affected, the muscles of the thigh and leg should be similarly vibrated. Follow this with passive and later resistive and active movements. If the pain resulting from motion gradually disappears within half an hour, such exercise is not contra-indicated. If, however, the pain persists, the movements should be diminished in number and extent, or they may be stopped for a time. Passive and active exercises, consisting of opening and closing the mouth, following the application of mechanical vibration with a rubber-covered disc vibratode to the temporo-maxillary articulation, are effective for overcoming contractions of the temporal, pterygoid and masseter muscles. A limited amount of exercise out doors if the weather permits, is essential to the welfare of these patients. Absolute rest means fixation of joints, atrophy of the muscles, and eventually a helpless patient. Fresh air and sunshine in a dry climate are beneficial, but they will not cure the disease.

In the after treatment of juxta-articular fractures, mechanical vibration with appropriate exercise, followed later by active exercise, applied immediately after the removal of the plaster cast, will remove oedema, relieve stiffness and lessen sensory disturbances. Prolonged interrupted vibration with the ball vibratode should be applied between the transverse processes of the spine where the nerves of the involved muscles have their exits. Interrupted vibration with the disc vibratode is also applied about the joint where motion has been limited by the fracture. To the contracted muscles should also be

applied prolonged vibration especially over their motor points. Radiant light and heat when used should precede the vibratory treatment. The static wave current and well-directed sparks are as a rule indispensable in most cases of arthritis.

The earlier the institution of treatment, the quicker and better the result. Vibratory treatment diminishes the swelling, increases the nutrition of the muscles, prevents the adhesion of inactive tendons in their sheaths, and shortens the period of repair. The relief of pain or the discomfort of fatigue. occasioned by the treatment should govern the length of each treatment. Following fractures, particularly, exercise is used as an adjunct, both passive and active, but should not be brought into service *until a good union has taken place.* The aim as in massage should be *"to move the neighboring parts but to keep the broken bone still"* while enhancing its nutrition. We should base our employment of mechanical vibration on what has been done by noted surgeons, such as Mm. Championniere, Tripier, Rafin, Marevery, Landerer, Franks, Tilanus and Wagner. Manual massage was used in intra- and para-articular fractures.

Mechanical vibration is indicated over the site of fractures and over the centers controlling the blood supply in cases of INCOMPLETE OR DELAYED UNION. Apply mechanical vibration to induce hyperemia in cases of FIBROUS UNION where "absorption and attenuation of the ends of the fragments, or eburnation has not occurred, and where there is no constitutional dyscrasia."

OEDEMA FOLLOWING FRACTURES may be promptly relieved by vibratory friction centripetally applied

over the muscles and interrupted vibration with moderate or heavy pressure about the joint and over the glands. In such cases elevate the limb, the hand or foot being the highest. Dust the surface to be treated with talcum powder to facilitate the administration of vibratory friction. First vibrate the lymphatic glands nearest the trunk. Centripetal vibratory friction of the muscles of the part beyond should follow. Interrupted vibration of the joint below is then given. This method is followed, the parts being treated from the trunk to the extremity in order, until the entire limb has been vibrated when a short vibratory friction from the extremity to the trunk may be given if deemed necessary. The rubber-covered disc vibratode is the best for such cases. Vibratory treatment will also relieve other oedemas temporarily or permanently, depending on their cause. In oedemas resulting from kidney, heart or liver affections, or thrombosis, the relief will be but temporary. Care must be taken in relieving oedema that the removal of the local infiltration does not overtax the heart, kidneys or lungs.

After breaking up adhesions the indications are vibratory and static electrical treatment, at first associated with passive movements, later to be followed by gradually increasing active exercise.

In strumous synovitis apply interrupted vibration over involved muscles, the joint being treated by light and d'Arsonvalization. Passive motion should be begun with the cessation of inflammation, but should be used with care. An indurated condition of the swelling, shown by pain and tenderness, any considerable amount of degeneration, infection, shooting pains and tenderness of the joint surfaces contra-

indicate passive motion. More rapid progress can be made in using passive motion, when the joint has a certain fixedness, if the movement be then made gradually and tentatively, directing the patient to take deep breaths and making the increased movement when he exhales.

Hiccoughs—singultus—are " due to a spasmodic contraction of the diaphragm, causing an inspiration, which is arrested by the sudden closure of the glottis so that a characteristic sound is emitted. Not infrequently it is due to irritation of the gastric membrane and sometimes it is a very troublesome symptom in uraemic poisoning." It occurs in visceral disease of the abdomen as gastritis, in some diseases of the nervous system as epilepsy, and hysteria, and apparently in some constitutional conditions, as typhoid fever, gout, nephritis, diabetes and diaphragmatic pleurisy. Mechanical vibratory treatment is oftentimes of great value in some forms of hiccoughs. A case worthy of special mention is that of a patient who had had hiccoughs for a year, and was finally successfully treated by Dr. House. In this case there was "pain in the epigastrium along the costal arch, especially over the right side." Drugs and other treatment had proved of no value. An examination of the patient previous to the institution of vibratory treatment showed "marked irritation at the right sacro-iliac synchondrosis, causing marked contraction of the quadratus lumborum muscle (a muscle of inspiration). Following up the course of the muscle to its attachment to the last rib, it was found that irritation of the diaphragm was conveyed reflexly through this means. The other points of reflex irritation were at the twelfth dorsal

and fifth lumbar spinal nerves." The brush (multiple point vibratode) was used "over the affected areas, and also over the diaphragm" with success. The author has had a similar case. The nervous supply of the diaphragm is the phrenic which Gowers believes can be reached at the 4th cervical vertebra where prolonged infrequently interrupted vibration with the ball vibratode may be given.

Obesity* being "due to deficiency of adrenoxidase and pancreatic ferments in the blood owing to functional debility of the adrenal system, the carbohydrates being inadequately broken down, fat accumulates in the subcutaneous and subserous and other tissues." The indications are to increase catabolism. Diet is restrained especially as to quantity. Small doses of thyroid extract, 2 to 3 grains t. i. d., may be used if deemed necessary. Saline cathartics or flushings are often essential to the treatment. A general vibratory treatment including an abdominal vibratory treatment, using heavy vibration, in combination with d'Arsonvalization, prescribed exercises, and walks of definite distances to meet conditions, usually give results. The static induced current or Nagelschmidt's high frequency apparatus are sometimes used. In any treatment involving tissue combustion, such combustion provoked must not be too rapid as toxaemia results from the throwing off of the wastes into the circulatory system. This must be provided for by keeping open the bowels and all channels of elimination.

* Sajous. The Internal Secretions and the Principles of Medicine, page 1867.

CHAPTER X

Relation of Mechanical Vibration to the Nervous System

There are certain indications for the vibratory treatment of spinal nerves and there are conditions and times where and when there is a question as to the advisability of inducing additional stimulation. Another point to be considered is how to affect the vaso-constrictors or the vaso-dilators as desired.

The two great systems are the *cerebro-spinal* consisting of the brain, spinal cord, and cranial and spinal nerves,—and the *sympathetic,* consisting of a connected chain of ganglia on each side of the spinal column, three plexuses,—cardiac, solar, and hypogastric, which consist of nerves and ganglia "in front of the spine in the thoracic, abdominal and pelvic cavities respectively," and of smaller ganglia in relation with certain viscera, and two kinds of nerve-fibres,—communicating and distributory. A third system, *the adrenal system,* is recognized by Sajous and his followers.

Three views* are held regarding nerve elements. One view is that the "independent physiological unit of nervous tissue" is the neuron consisting of "a ganglionic cell with all of its processes. The axis cylinders of all nerve fibres arise from ganglionic cells and not from a network of fibres. All nerve fibres terminate finally by means of terminal arborescences or telodendrites. The nerve cells act as

* Landois. Text-Book of Human Physiology, page 621.

physiological centers for automatic or reflex movement, for sensation, perception, for trophic and secretory functions, and the fibres represent a conducting apparatus."

A second view considers "the fibrillary substance or the neuropile as the medium of nervous activity. The fibrillary substance is present in the great mass of gray matter, which represents a fine lacework or network of nerve fibrils. It can be seen further in the nerve cells and in the fibres passing off from them."

The third view **holds* that the nervous system consists of cells, (the neuron being "not a cell but an organ composed of many cells), developed and nourished by leucocyte-granulations and traversed by the oxygen-laden adrenoxidase," and that "the ground substance and Nissl granules of nerve-cell bodies and the myelin of their axis-cylinders or nerves are to the nerve-cell what the cytoplasm is to other tissue-cells. The neuro-fibrils, including those of the axis cylinders, are nerve capillaries through which the nerve-cells are supplied with oxygen-laden adrenoxidase" which they receive "from the general circulation through the intermediary of the neuroglia fibrès (also capillaries) and the neuroglia-cells which regulate the volume of plasma admitted into the fibres. The axis cylinders† are the extension in the nerve of the neurofibrils which enter the dendrites from above and form a mesh work in the cell body (the main cell of the neuron) and around its nucleus." Sajous thinks "that the myelin of

* Sajous. The Internal Secretions and the Principles of Medicine, page XI, Vol. II.

† Ibid, page 927.

nerves is a compound rich in phosphorus which, when in contact with the oxygen-laden adrenoxidase circulating through them, generates nerve-energy" and "that the ground-substance, the Nissl granules and the myelin in the cell-bodies of neurons and their dendrites, are also phosphorus-laden compounds which, when in contact with the adrenoxidase circulating through them, generate nerve-energy."

NERVE FIBRES CLASSIFIED ACCORDING TO FUNCTIONS* *are:*

(1) Centrifugal: (a) motor, (b) secretory, (c) trophic.

(2) Centripetal: (a) sensory, (b) nerves of special sense, (c) reflex or excito-motor nerves.

(3) Intercentral nerves connecting ganglionic cells.

What concerns us particularly is the NUTRITION of the nerve as it is affected by various pathological conditions and the direct bearing of the nerve to stimulation or inhibition. "That anabolism† from the blood must take place in the nervous tissue is indicated by the fact that the irritability of the nerve diminishes after compression of the blood vessels, and returns on restoration of the circulation. The ganglia form much lymph." It has been demonstrated that changes occur "in the appearance of the cell and its nucleus."‡

The chromatic substance accumulates in the cells when not active, whereas activity induces its consumption. Vas|| noted that a mild stimulation caused the cell to swell and clear up in the center,

* Landois. Text-Book of Human Physiology, page 677.

† Landois. Text-Book of Human Physiology, page 628.

‡ Howell. Text-Book of Physiology.

|| Starr. Organic Nervous Diseases, page 27.

and "Mann showed that functional activity of the cell is accompanied by an increase in the size due to inhibition of the lymph lying in the cavity about the cell, the cell at work filling up the cavity in which it lies. When activity goes on to the point of fatigue then a shrivelling of the cell begins, first in the nucleus then in the body." These changes were the result of various stimuli both electrical and *mechanical* as running." If a cell that has been stimulated be given sufficient rest, it will revive and resume its functional activity but it is necessary that the blood supply be perfect and that the blood contain the requisite nutrition. There may be an injury to the neuron of a character which cannot be repaired, which will lead to organic nervous disease. According to Dr. Starr bacteria as well as leucocytes may be found in the neuron body and its branches. Howell* believes the energy to be derived from "a metabolism which consists essentially in the splitting and oxidation of the complex substance in the protoplasm of the cell."

THE SPINAL CORD is supplied with *blood vessels* which are non-anastomosing terminal arteries. When an embolus occurs in such an artery "an area of softening" results. Some of the veins empty their contents eventually into the vena cava, and others into branches of the jugular.

The spinal cord controls various voluntary and involuntary actions of the human body. Nerve centers for many of these functions have been discovered, but others are as yet unknown or are in doubt, some authorities claiming one and some another region to be the center for a certain act or impulse,

* Howell. Text-Book of Physiology, page 139.

and yet again in some instances experiments have been made on the lower animals resulting in the discovery of certain centers which have not as yet been verified in respect to man. Nerve centers are considered in Chapter VI, and specifically in connection with the consideration of various organs when their pathological states are discussed.

THE TWO ROOTS OF THE SPINAL NERVES, ANTERIOR AND POSTERIOR, differ in function.

The anterior roots* supply centrifugal fibres to

"1. Striated muscles of the trunk and of the extremities under the control of the will. Every muscle receives its motor fibres from several anterior roots and not from a single root, while every root distributes fibres to a related group of muscles.

"2. Motor fibres to a number of organs provided with unstriated muscle fibres as urinary bladder, the uterus, vasa deferentia, the skin.

"3. Motor fibres for the unstriated muscles of the vessels, the vaso-motors.

"4. Inhibitory fibres for the contraction of the vascular muscles (known only in part): vaso-dilators.

"5. Secretory fibres for the sweat.

"6. Trophic fibres for the tissues."

The posterior roots supply sensory nerves to the skin and internal tissues except for the face and the anterior part and inner portions of the head. "They also contain tactile nerves for the cutaneous surfaces indicated and can convey" irritations exciting reflex action.

Stimulation of the anterior roots† causes:

1. Convulsive movements of muscles.

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* Landois. Text-Book of Human Physiology, page 717.

† Brubaker. A Compend of Human Physiology.

2. The formation of a secretion in glands.
3. Changes in the calibre of blood vessels.
4. Inhibition of the rhythmic activity of certain organs.

Division of these roots is followed by:

1. Loss of muscular movement (paralysis of motion).
2. Cessation of secretion.
3. Cessation of vascular changes.

Stimulation of posterior roots causes:

1. Reflex activities.
2. Conscious sensations.
3. Inhibition of the rhythmic activity of certain organs.

Division of the posterior roots is followed by:

1. Loss of reflex activities.
2. Loss of sensation in all parts to which they are distributed.

Sajous'* view in regard to the spinal system supported by evidence is embodied in:

"That the pituitary body is the general and governing center of the spinal system, which includes the gray substance of the base of the brain, pons, bulb and spinal cord, and the nerves derived from any of these structures, cranial or spinal, though subsidiary centers are also present in the bulb and spinal cord."

THE SYMPATHETIC SYSTEM is composed of three cervical, eleven dorsal, four lumbar and four sacral ganglia, and two† kinds of fibres (1) "medullated supplied to it as visceral branches by cerebral and

* Sajous. The Internal Secretions and the Principles of Medicine, page XI, Vol. II.

† Landois. Text-Book of Human Physiology, page 718.

spinal nerves, (2) fibres of Remak which arise from sympathetic ganglia," the medullated fibres being "(a) sensory; (b) motor for vessels (vasomotors) and viscera, the latter entering into sympathetic ganglia whence Remak's fibres, as well as medullated fibres, pass from the ganglion-cells to the innervated areas; (c) inhibitory fibres and vaso-dilators, in the course of which no sympathetic ganglia are intercalated."

*The situation of the ganglia** varies in their relation to the vertebrae in the different regions.

The superior cervical ganglion "is situated in front of the longus capitis muscle and the transverse processes of the 2nd and 3rd cervical vertebrae. (Gray says that sometimes it extends as low as the 4th or 5th.) It sends three or four rami communicantes to the anterior divisions of I to III cervical nerves, a communicating branch to ganglion nodosum of vagus nerve, a communicating branch to the hypoglossal nerve, the jugular nerve, the internal carotid nerve." The last three branches come from the upper part of the ganglion. The following are from the lower part of the ganglion. The external carotid nerves, pharangeal branches, laryngeal branches, and superior cardiac nerve. The superior cervical ganglion connects with the middle cervical ganglion and from this connection a branch is sent "to the anterior division of the fourth cervical nerve." Anteriorly the superior cervical ganglion is "internal to the sterno mastoid high up."

The middle cervical ganglion "lies at the level of the 5th or 6th cervical vertebra." It gives off the middle cardiac nerve, and "communicating branches

* Belousow. Krause. Synoptic Charts of the Nerves of Man.

to the anterior divisions of the 5th, 6th and 7th cervical nerves." Two trunks connect it to the inferior cervical ganglion. Anteriorly this ganglion is found "behind the middle of the sterno mastoid."

The inferior cervical ganglion "lies at a slightly lower level than the middle cervical ganglion." (Gray says: "between the base of the transverse process of the last cervical vertebra and the neck of the first rib.") "It sends communicating branches to the anterior divisions of the 8th cervical and 1st dorsal nerves." (Gray states 7th and 8th cervical.) The inferior cardiac nerve, entering into the formation of the cardiac plexus, arises "from the inferior cervical and first thoracic ganglia." Other branches form the subclavian plexus of which "the inferior thyroid and vertebral plexus are the largest."

The thoracic ganglia number ten, eleven, or twelve. The first and second thoracic are usually as one; and when these two are with the inferior cervical ganglion, the number of the thoracic ganglia is reduced to ten. Most of the thoracic ganglia "lie in front of the necks of the corresponding ribs. In the middle portion of the thorax they are slightly more external, in front of the transverse processes. Lower down they lie closer to the bodies of the vertebrae. They may be situated nearer the upper border, or nearer the lower border of the ribs, or in the intercostal spaces." The "greater splanchnic nerve comes from the 6th to the 9th thoracic ganglia. The roots pass in front of the bodies of the dorsal vertebrae. The smaller splanchnic nerve comes from the 9th to the 11th thoracic ganglia."

The lumbar ganglia "lie on the bodies of the lumbar vertebrae." They usually number five.

The sacral ganglia of which there are "four, or three, lie on the anterior surface of the sacrum, somewhat internally to the anterior sacral foramina.

The coccygeal ganglion "lies in front of the anterior surface of the second piece of the coccyx."

The hypogastric plexus lies "in front of the body of the fifth lumbar vertebra, and of the promontory, and also in front of the left iliac vein."

Sajous states that the sympathetic system ("general motor system") has its governing center in the posterior pituitary body and that it is structurally a part of the general cerebro-spinal system. He believes that the function of the "sympathetic system* is to transmit efferent impulses and is purely vasoconstrictor, its field being limited to the small arteries or arterioles, and that it is independent of the vaso-motor system (whose action is general) being capable, unlike the latter, of influencing each organ individually, and that its terminals form part of the mechanism of all organs, and that the specific rôle of its terminal fibres is to oppose the stricto-dilators and restore the arterioles of an organ to their normal calibre when the functional activity of that organ is to cease."

His conclusions† in regard to the study of the nerve supply of the voluntary muscles, the salivary, mammary, and cutaneous glands are as follows:

"The general motor nerves distributed to the organs above mentioned divide, when near their destination, into two branches: (1) an 'extrinsic vasoconstrictor' branch, which supplies filaments to the

* Sajous. The Internal Secretions and the Principles of Medicine, pages 294 and 1198.

† Sajous. The Internal Secretions and the Principles of Medicine, page 294.

arteries outside the contractile or secretory structures of the organ concerned, and increases the speed of the blood-flow through the latter during activity by reducing the calibre of these arteries; (2) an 'excito-regulator' branch, which supplies the intrinsic structures of the organ and governs their functional activity, and which in turn divides into (a) an excitor and (b) an intrinsic constrictor branch."

"As the vibratory rhythm of the stream of impulses transmitted by a nerve always corresponds with that of the structures to which its terminal filaments are distributed, any variation of vibratory rhythm transmitted from the cerebro-spinal centers by the general motor nerves gives rise to a corresponding variation of activity in the structures or organs supplied by these terminal filaments.

"In all the above-mentioned organs the oxidizing substance—a combination of adrenal secretion and oxygen formed in the lungs and of which the blood-plasma is the vehicle—is the physico-chemical agency through which cellular metabolism is sustained during *passive* functional activity, and increased during *active* functional activity."

He states also "that the volume of blood which circulates through any organ, whether the latter be in the passive state or functionally active, is regulated by the joint action of the motor and sympathetic centers in the posterior pituitary, and that the cranial and sympathetic filaments to the arterioles owing to the presence in the walls of the arterioles of spirally disposed muscles, endow these vessels with a special property; that of increasing

the vis a tergo motion of the blood in order to overcome the resistance of the capillaries."

THE FUNCTIONS OF THE SYMPATHETIC SYSTEM according to Hall* are:

"1. Cardio-acceleration and cardio-augmentation through the branches from the cervical ganglia.

"2. Secretory impulses to the salivary glands, the stomach, the pancreas, the liver, the small intestine, the large intestine, the kidneys.

"3. Vaso-motor impulses, both constrictor and dilator to all arteries and arterioles.

"4. Motor impulses to the muscular coats of the stomach and intestines, causing peristalsis and controlling the pylorus and the cardia of the stomach.

"5. Motor impulses to the muscularis mucosa of the alimentary canal, causing movements of the mucosa.

"6. Inhibition."

A THIRD SYSTEM is the "ADRENAL SYSTEM" which includes "the pituitary body, the adrenals and the thyroid gland including the parathyroids." Sajous' explanation is:

"That the anterior pituitary body is a lymphoid organ which, through the intermediary of a center located in the posterior pituitary body and a nerve-path in the spinal system, the upper dorsal sympathetic ganglia and the splanchnic nerves, governs the functional activity of the adrenals.

"The anterior pituitary body governs, through the posterior pituitary body, all the oxidation processes of the body. The center in the posterior pituitary body through which the anterior pituitary body gov-

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* Sajous. The Internal Secretions and the Principles of Medicine, page 1185.

erns the adrenals also controls the functional activity of the thyroid gland, and thus constitutes the 'adreno-thyroid' center; which is governed by the test organ (the sensory organ between the two lobes of the pituitary body).

The adrenal system is "the immunizing apparatus of the body" and its principal function is to supply an internal secretion which absorbs the oxygen of the air to carry it to the tissues. It is the system* through which cardiac action, respiration and general cellular oxidation are maintained. The processes governed by the posterior pituitary body "include all functions which require conscious and to a certain extent intelligent co-operation, and are not mere reflex phenomena as those elicited from subsidiary nerve centers, in the medulla and spinal cord."

THE VASO-MOTOR CENTER supplying motor fibres to the arterial muscles is thought by Landois to be in the medulla oblongata. This center may be stimulated directly or reflexly. "In animals in which the center is irritated electrically it has been found that single induction shocks of moderate strength are effective only when two or three shocks occur in a second. There is thus a summation of the effects of the individual stimuli." Ten or twelve strong or twenty to twenty-five moderately strong shocks per second induce the maximum vaso-constrictor effect, shown by the maximum blood pressure.

"THE VASO-MOTOR NERVES pass from their center in part directly† through the tract of some of the cerebral nerves to their distribution:—through the trig-

* Sajous, page 231.

† Landois. The Text-Book of Human Physiology, page 763.

eminus in part to the interior of the eye, through the hypoglossus to the tongue, through fibres of the vagus to the heart and in limited number to the lungs and to the intestines. All other vaso-motor nerves descend in the spinal cord and are connected within the gray matter with centers of subordinate significance by means of contact. They make their exit, through the anterior roots of the spinal nerves, then pass through the visceral branches into the ganglia of the sympathetic cord. In the sympathetic cord they pass upward or downward and finally hence either to the vascular plexuses or through other visceral branches again into the trunks of spinal or cerebral nerves and from these to the respective vessels." Acording to Sajous'* view "each general motor nerve distributed to a part supplies it with its vaso-motor fibres as well as with all others distributed to it, unless associated with a special nerve, such as the vagus," and consequently he concludes "that the vaso-motor center in the medulla must coincidently be that of the general motor nerves or at least the region where the latter assume vaso-motor functions." He concludes† that there is no individual center in the medulla to be called "vaso-motor center" and says "the general vaso-dilation after section of the medulla is due to the interruption of the stream of general motor impulses through which tonic contraction of the arteries is maintained, and which the medulla seems to transmit." He thinks the vaso-motors for the arterioles are from the sympathetic system under control of the sympathetic center

* Ibid, page 458.
† Ibid, page 463.

and that the larger vessels are controlled by the bulbar vaso-motor center.

THE VASO-DILATOR NERVES or vaso-inhibitory nerves or vaso-hypotonic nerves should be further investigated. Some authorities (Landois) believe that they exist as special nerves or associated with vaso-constrictor and other nerves. Sajous states that the functions of vaso-constrictor and vaso-dilator nerves of muscles are filled " through the agency of their motor nerves," and that " stricto-dilators " which are fibres of a cranial motor or secretory nerve (the vagus, facial, etc.), cause dilation of an arteriole during functional activity, and that the vaso-constrictor fibres of the sympathetic (whose control is limited to arterioles or small arteries) restore a passive condition. He also believes that "active vaso-dilation exercised through vaso-dilator nerves is limited to the arterioles.*" Howell states that "the dilator fibres† end presumably in the walls of the arteries, and when stimulated their impulses inhibit the tonic contraction of this musculature and thus indirectly bring about a relaxation." Sajous believes that the vaso-constrictor nerves cause "constriction of the nutrient arteries of a vessel and vaso-dilation results, the vaso-motor nerves become not vaso-dilators, but stricto-dilators."

For a further insight into the subject of vaso-constrictors and vaso-dilators the reader is referred to chapter VII. Tables of the vaso-constrictor and vaso-dilator neural cells are given in Chapter VI.

* Sajous. The Internal Secretions and the Principles of Medicine, page XII, Vol. II.

† Ibid, page 1124.

† Howell. Text-Book of Physiology, page 597.

Stimulation of PRESSOR and DEPRESSOR fibres of "different afferent nerves" excites or inhibits the action of the vaso-motors. Loven believes that "the first effect of stimulating every sensory nerve is a pressor action" and "S. Mayer and Pribram found that mechanical stimulation of the stomach, especially of its serosa, caused pressor effects."

Sajous thinks "the depressor nerves are those through which the thyroid center regulates the circulation of the anterior pituitary body and of the thyroid apparatus."

THE VASO-MOTORS TO THE HEAD ARE MOSTLY FROM the cervical sympathetic, *to the upper extremities* "through the anterior roots of the middle dorsal nerves, into the thoracic sympathetic, and upwards to the last thoracic ganglion, and from thence to the rami communicantes to the brachial plexus (Schiff, Cyon)," *to the lower extremities* "through the nerves of the lumbar and sacral plexuses into the sympathetic, and from thence to the lower limbs (Pflüger, Schiff, Cl. Bernard)," *to the skin of the trunk* through the dorsal and lumbar nerves, *to the lungs* "from the dorsal spinal cord through the first thoracic ganglion (Brown-Sequard, Fick and Badoud, Lichtheim) *to the abdominal viscera* from the splanchnic" (v. Bezold, Ludwig and Cyon).* A light cutaneous stimulus lowers the cutaneous temperature, and lessens "the volume of the corresponding limb, and sometimes causes an increase of the general blood pressure and change of heart-beat."

The *body temperature and even the body weight* are through *stimulation of particular vascular areas*

* Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 856.

acted upon by the vasc-motor nerves. Stimulation of a motor nerve or the spinal cord causes not only the *contraction of the corresponding muscles,* but also *dilatation* of their blood-vessels, (C. Ludwig and Sczelkow, Hafix and Gaskell)—the dilatation of

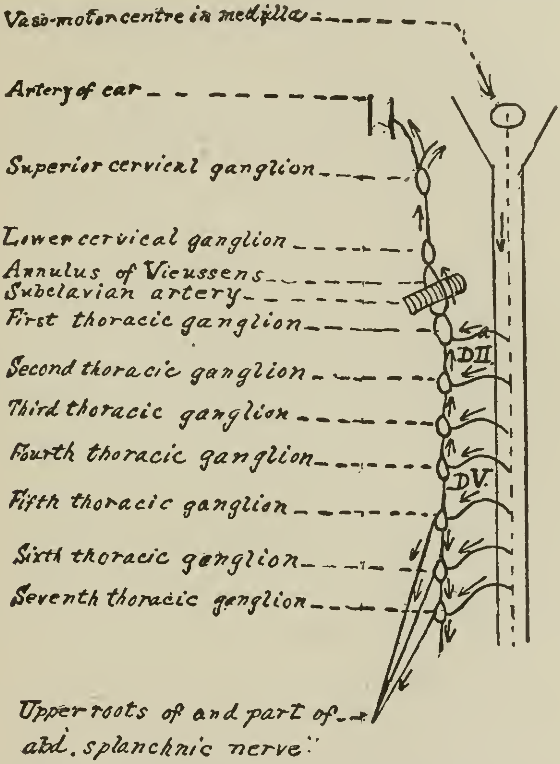

Fig. 49.—Diagram of the paths of vaso-constrictor fibres along the cervical sympathetic and part of the abd. splanchnic. Constrictor impulses pass down the cord from the vaso-motor center of the medulla. *a. ramus communicans.* (After Foster.)

the vessels taking place even when the muscle is prevented from shortening. Gaskell observed under the microscope the dilatation produced by stimulation of the nerve to the mylo-hyoid muscle of the frog. Some think that vaso-dilator fibres arise from all

parts of the spinal cord, the ear receiving its supply from the lowest cervical ganglion and first dorsal. The nervi erigentes from the sacral plexus when stimulated cause the arteries of the penis to dilate. (Eckhardt, Loven.)* In applying mechanical vibration take as a guide the rule, " Stimuli, which are applied at long intervals to the nerve, act especially on the vaso-dilator fibres, while tetanizing stimuli act on the vaso-motors (constrictors). The latent period of the vaso-dilators is longer and they are more easily exhausted than the vaso-motors (Bowditch and Warren)."

Mechanical vibration when applied to an inflamed nerve elicits pain if a sensory nerve or contraction if a motor nerve which may at first be increased or exaggerated. Prolonged application results in diminution or disappearance of the pain or contraction. It is of interest to note Tigerstedt's findings. "Tigerstedt† discovered that the minimal value of the mechanical stimulation (induced by the falling of a weight upon the isolated nerve) is 900 milligram-millimeters, the maximal value from 7000 to 8000. More powerful stimulation causes exhaustion, but this does not extend beyond the irritated area. The mechanically irritated nerve does not acquire an acid reaction. A lesser degree of pressure or tension increases the irritability, which again diminishes after a short time. The work done by the irritated muscle as a result of this irritation was as much as 100 times greater than the kinetic energy of the mechanical nerve irritation. If a mechanical influence acts gradually the nerve may lose its con-

* Landois and Stirling. Text-Book of Human Physiology, page 863.

† Landois. Text-Book of Human Physiology, page 629.

ductivity or its irritability without any manifestation of irritation in the process." Heidenhain's tetanomotor, a vibratory apparatus, is used in investigation work to cause nerve stimulation mechanically. It will induce "a tetanus lasting up to two minutes. Spinal cord stimulation may be from interrupted vibration or peripheral nerve stimulation frictionally. Peripheral stimulation results from local vibrations with the disc vibratode. Stimulation or inhibition may result according to the length of time and degree of pressure exerted. The heart may be slowed or quickened by nerve vibration. It has been demonstrated that vibration from various devices* induced muscular contraction (Langendorff and Axenfeld), and stimulatory effects (Borruttau). ." Bechterew and Tschigajew* by vibrating the whole body induced sleep in about ¼ hour. Buchheim obtained stimulatory effects on the sympathetic and vagus in the neck according to the site of application." Nerve vibration reflexly affects the activity of organs. " Nebel, Lennalm and others found that in some cases paralyzed nerves would react to mechanical (a vibratory nerve pressing) but not to electrical stimulus." Mechanical stimuli act when sufficiently rapid to cause a change in the nerve particles. Their effects vary: *if the pressure on a mixed nerve be continuous the motor fibres are paralyzed sooner than the sensory.* If the pressure be increased gradually an increase of excitability follows to be later followed by a decrease. According to Kronecker and Zederbaum *pressure* applied to a mixed nerve abolishes reflex conduction before motor con-

* Cyriax. Vibrations and Their Effects.

duction. Fontana, 1758; found that a stimulus increased very gradually caused the nerve to be inexcitable without showing stimulation signs. A mechanical stimulus does not cause the nerve to become acid. When a motor nerve is irritated, the nearer the nerve center the greater the excitability, that is a muscle that contracts with a given stimulus at a given point will answer with a greater contraction if the same stimulus be applied nearer the spinal cord. Reflex contractions* caused by irritating a sensory nerve "are the greater the more proximally the irritation is applied." Yet another point to be noted is that in the same nerve a stronger stimulus is required for it to act on some muscles as of extensors than on others as flexors, as has been demonstrated on the sciatic nerve of a frog. The facts set forth may ultimately aid in estimating the degree of stimulation indicated for various groups of muscles which it may be advisable to affect.

If stimulation be continuous and excessive, fatigue followed by exhaustion results. Bernstein demonstrated that " a nerve trunk is more slowly fatigued than a muscle, but it recovers more slowly"† which suggests a judicious employment of vibratory stimulation according to the case treated, that over stimulation be avoided.

Nerves are capable of carrying impulses even after there is loss of excitability. We should not stimulate a nerve *too rapidly* in order that the nervous impulse may be allowed to travel without interruption. The impulse travels in a motor nerve at from "100 to

* Landois. Text-Book of Human Physiology, page 633.

† Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 683.

120 feet per second as found by v. Helmholtz and Baxt" and from 90 to 280 in sensory nerves, as shown by v. Helmholtz. It is less in the visceral nerves, being but 26 feet in some branches of the vagus (Chauveau). Reflexes are best induced by 16 stimuli per second.

REFLEX ACTIVITY is considered by some authorities to be of great importance as it is believed that in chronic visceral diseases "the spinal muscles lying over the reflexly affected spinal nerve center will generally be found contracted, and if long continued more or less atrophied," and that stimuli "applied directly over the affected center," act as a *vis a tergo* to restore normal functionating power. Interrupted vibration with the ball used alternately on each side of the spine between the transverse processes is an effective stimulus.

"Strong stimulation of a sensory nerve inhibits reflex movements. The reflex does not take place if an afferent be stimulated very powerfully (Goltz, Lewisson)."

Setschenow distinguished *tactile* reflexes, which are discharged by stimulation of the nerves of touch; and *pathic* which are due to stimulation of sensory (pain conducting) fibres. He and Paschutin suppose that tactile reflexes are suppressed by voluntary impulses, and the pathic by the center in the optic lobes."

Jendrassik makes the following subdivision of reflexes:*

"I. Spinal (tendinous, muscular, periosteal, bony, articular, genital-muscule). Pathologically mani-

* Landois. Text-Book of Human Physiology, page 731.

fested as flexor, less often extensor movement of the lower extremities.

II. Cerebral cortical caused by tickling.

III. Complex from a spinal and a cerebral reflex center,—sneezing, vomiting, swallowing, coughing, evacuation of bladder, and rectum, and ejaculations."

The following is of interest as regards *reflexes:*

"1. Reflexes are more easily and more completely discharged when the specific end-organ of the afferent nerve is stimulated, than when the trunk of the nerve is stimulated in its course" (Marshall-Hall).

2. A stronger stimulus is required to discharge a reflex movement than "for the direct stimulation of motor nerves."

3. A movement produced reflexly is of shorter duration than the corresponding movement executed voluntarily. Further the occurrence of the movement after the moment of stimulation is distinctly delayed.

In connection with the subject of reflexes the question arises whether the spinal cord is or is not stimulated when we stimulate the posterior root. "As the spinal cord conduces to the brain impulses communicated to it from the stimulated posterior roots, but does not itself respond to stimuli which produce sensations, Schiff has applied to it the term 'aesthesodic'." Further as the cord can conduct both voluntary and reflex motor impulses, without, however, itself being affected by motor impulses applied to it directly, he calls it *"kinesodic."* Many others believe that direct stimulation will excite the spinal cord.

Reflex time or the time for carrying impulses by means of the afferent nerves through the cord to the efferent varies, in the frog being .0008 to .015 second, but is increased by "almost 1-3 if the impulses pass to the other side of the cord." It lessens as the strength of the stimulus is increased "and may even become of minimal duration." (J. Rosenthal.)

What investigation has demonstrated of the relation that stimuli bear to effect has been aptly summarized by Kirke acording to Pflüger as follows:

"1. *Law of unilateral reflection.*— A slight irritation of the surface supplied by certain sensory nerves is reflected along the motor nerves of the same region. Thus if the skin of a frog's foot be tickled on the *right* side, the right leg is drawn up.

2. *Law of symmetrical reflection.*—A stronger irritation is reflected, not only on one side, but also along the corresponding motor nerve of the opposite side.

3. *Law of intensity.*—In the above case, the contractions will be more violent on the side irritated, but it must not be assumed that the effect is always in proportion to the strength of the stimulus.

4. *Law of radiation.*—If the irritation (afferent impulses) increases it is reflected along other motor nerves till at length all the muscles of the body are thrown into action.

The vagus nerve is particularly worthy of notice as it has such a wide range of control. "It supplies (1) motor influence to the pharynx and œsophagus, stomach and intestines, to the larynx, trachea, bronchi and lung; (2) sensory and in part (3) vaso-motor influences, to the same regions; (4) inhibitory influence to the heart; (5) inhibitory afferent impulses to

the vaso-motor center; (6) excito-secretory in the salivary glands; (7) excito-motor in coughing, vomiting, etc."

Scientific conclusions are of importance to all employing vibratory stimulation of whatever form—static wave current, high-frequency current, or mechanical vibration. They demonstrate the existence of factors that are too often overlooked.

VIBRATORY FRICTION acts on nerve endings of both systems and *interrupted vibration* acts upon the nerve trunks and centers. Lightly applied, interrupted vibration stimulates while stronger or longer fatigues or exhausts the nerves, according to the degrees, and may affect the blood flow, causing a numbness from diminished nutrition. *Percussion* excites "languid" nerves, but if *long* and *vigorous* may over stimulate them and exhaust their ability of perceiving impressions and allay morbid irritability, a point of therapeutic interest.

LIGHT PERCUSSION at first increases pain, but later diminishes it, often causing it to finally disappear. The greater the sensitiveness of the nerve, the less pressure should be at first employed.

VIBRATORY STROKING has a soothing effect and vibratory friction by acting on the nerve of the blood vessels and lymphatics has a marked effect on inflammation. It also helps to give the tired nerves their necessary blood supply.

WHEN DEEP INTERRUPTED VIBRATION, even compressing in character, is used pressure on the trunk is best made over the "motor points." Douglas Graham says "it is often surprising how much better contraction can be obtained from percussion than from a faradic current." When made on the solar

plexus below the xiphoid cartilage and the lumbar ganglia, situated about two inches on each side of the umbilicus, the patient should exhale slowly and forcibly, breathing deeply. All abdominal viscera will be affected.

If deep interrupted vibration is applied to the aortic lumbar plexus the vibratode should be placed about two inches below the umbilicus. During applications to these regions the patient should lie on his back, the head and shoulders being elevated, the legs being flexed. The patient should breathe deeply and during forced exhalation the pressure should be increased, the vibratode being carried more deeply at the sites of application. Each impulse should be but for a few seconds at each site, the period of rest being as long or twice as long as the time of contact. The vibratodes should be applied but for three or four times and great care must be exercised that the pressure is not applied too suddenly or too heavily, as unpleasant effects, such as nausea and depression may result.

Deep interrupted vibration with moderate or deep pressure is stimulating if the application is short, but is exhausting if too strong or if it be applied too long.

In applying interrupted vibration to the spine place the ball vibratode over the site of the ganglion and make the pressure close to the spinous processes and between the transverse processes, or between the ribs near the spine.

The "*chief actions of the sympathetic* nerves on the one hand, and of the *cranial and sacral autonomic* nerves on the other, in the regions of double supply" are as follows:

Tissue.	*Effect of stimulating the Cranial and Sacral Fibres.*	*Effect of stimulating the Sympathetic Fibres.*
"Heart	Inhibition	Increase in rate and strength.
Bl. ves. of salivary glands and most of buccal mucous membrane.	Dilatation	Dilatation and in certain cases contracture.
Salivary glands	Secretion	Secretion.
Muscular coats of alimentary canal.	Chiefly contraction, sometimes apparent inhibition.	Chiefly inhibition, sometimes contraction
Bladder	Strong contraction	Feeble contraction.
Ext. generative organs	Inhibition	Contraction
Bl. ves. of anal mucous membrane and of ext. generative organs.	Dilatation	Contraction."

CHAPTER XI

The Therapeutic Application of Mechanical Vibration to the Nervous System

The blood vessels of the head receive their vaso-motor supply largely from the cervical sympathetic, but the nerves reach the vessels not alone through the cervical sympathetic, but other tracts as well. Spina thinks that the cerebral vessels have a special vaso-motor center extending to the 3rd cervical vertebra. Stimulation of the sympathetic supplying the cerebral vessels results in a slowing "of the blood current in the small cerebral arteries and increases the resistance in them." Vaso-dilatation of the head often results from stimulation of the abdominal sympathetic and vaso-constrictor effects arise from energetic vibration (manual—Cyriax) in the coronal suture. The vaso-constrictor neural cells for the brain, face, scalp, eye and mucous membrane of the nose and mouth are found in the second, third and fourth dorsal segments (Arnold).*

"The vaso-dilator neural cells for the face and scalp are in the nuclei of the seventh and ninth cranial nerves, for the mucous membrane of the nose, the soft palate, mucous membrane of the upper lip and gums in the nucleus of the seventh. Those for the floor of the mouth, the lower lip, the mucous membrane of the cheek, the lower gums and the tongue in the nucleus of the ninth."

* Examination of the Back. *Medical News,* March 18, 1905.

The writer has relieved CEREBRAL CONGESTION by applying interrupted vibration with the ball vibratode between the second and third dorsal vertebrae on each side alternately for two periods of five minutes each, an interval of a few minutes' rest following the five minutes, thus reducing the blood pressure.

INSOMNIA when associated with nervousness is best treated by removing the cause of the over-excitability of the nervous system and by lowering the blood pressure. These results may be induced by the d'Arsonval current or mechanical vibration. An agent inducing sleep, according to Sajous, causes "constriction* of the arterioles of the anterior pituitary body (including its test organ, which governs the adrenals) and also of the arterioles of the thyroid gland," and this center lowers general metabolism which in turn by affecting the heart and blood vessels, causes general vaso-dilation. This increases the quantity of blood "in the splanchnic area and other deep vessels, and withdraws a corresponding quantity of blood from the peripheral organs, including the cerebro-spinal system. Lessened metabolic activity and diminution of adrenoxidase inhibit the functional activity of the neurons and provoke unconsciousness."

Insomnia is often favorably affected by mechanical vibratory treatment applied to the neck, thereby relieving cerebral congestion or by centrifugal friction toward the extremities for the purpose of inducing the blood from the head, thereby relieving the brain. Abdominal vibration favors sleep also. Relaxation,

* Sajous. The Internal Secretions and the Principles of Medicine, page 1265.

lessened nerve irritability and diminished arterial tension are the indications met by mechanical vibration. Local causes which influence the conditions must also be treated according to indications. Attention should be given to a proper application of spinal vibration in conformity with the indications of each case. Cyriax calls attention to the fact of Charcot's vibrating casque having been used to promote sleep. Body vibration will also induce sleep.

IN CEREBRAL ANAEMIA, centripetal friction or localized spinal vibration should be employed. Regulation of diet, and hygiene—as baths, outdoor exercise, and proper attention to the bowels are indicated.

NERVOUS HEADACHE may often be benefited by vibratory stroking as it has a sedative effect on cutaneous nerves.

MIGRAINE OR HEMICRANIA is caused* by "toxic wastes" (Sajous thinks probably the purin group) stimulating the sympathetic center thereby causing general constriction of the arterioles, except those which cannot contract; because their walls are functionally or organically weak. When the sympathetic system alone is stimulated, there results a contraction of all the other arterioles of the body except those of the affected region causing "pressure and hyperæmia of the local nervi nervorum." A second form of migraine, the vaso-motor form, is due to sympathetic irritation plus stimulation of the vasomotor center, resulting in a *general* vaso-constriction except in the "diseased or lax" arterioles which are dilated. It is like the first form, only aggravated. The blood pressure is raised, and there is pupillary

* Sajous. The Internal Secretions and the Principles of Medicine, page 1522.

contraction. Migraine may be caused directly or reflexly by overeating, improper diet, uterine disorders, or excessive muscular fatigue, carious teeth, eyestrain, nasal or ophthalmic affections or adenoids.

The treatment should be directed according to Snow, to "(1) improving the general nutrition, (2) to lessening the nervous irritability by restoring or establishing a proper stability of the nervous system, (3) to correcting or removing exciting causes, as far as possible, which induce attacks, and (4) to relieving the attacks when they do occur."

The first indication calls for colonic flushings or saline purgatives; light, light baths, or hot air baths to promote elimination, outdoor exercise, and dietary restrictions as; water freely, milk, koumiss, zoolak, cooked fruit and vegetables—a meat free diet, no eggs, coffee, tea, or stimulants.

The second may be successfully managed by local or general vibratory treatment, with other physical measures as d'Arsonvalization if necessary, depending upon indications. The stroke, speed and pressure exerted should be adapted in every case to the condition of the patient. Above all, *no pain* must be caused by the treatment. A soothing effect is to be sought. Vibratory stroking from before backward and from the occiput down and outward and over the neck anteriorly with a rubber-covered disc, and interrupted vibration with moderate or deep pressure over the painful areas, is sometimes useful. Kellogg believes that sometimes there are "points of induration or thickening in the trapezius and scaleni muscles" which seem to have some relation to some attacks of migraine. Such cases should receive indicated local treatment with the disc vibra-

tode. Vibratory treatment of the liver and abdomen, which will improve digestion, associated with a restricted diet, are often indicated, as well as applications of proper spinal vibration with the ball to meet conditions, Cyriax* believes that the 2nd cervical nerves seem to have fibres supplying the head and uses frictions on the nerves to relieve congestive headaches with good results frequently. He says such frictions have an antipyretic effect. The posterior roots† are "posteriorly near the middle line as they emerge from the trapezius" and the anterior roots are "more externally and anteriorly under cover of, and in front of that muscle." The vibratode should be placed over the site of these branches and the frictions should be from "before backwards" to the vertebral exit of these nerves. Cyriax‡ also remarks in regard to CHRONIC HEADACHE, that although it is supposed that myositis of the neck muscles may be a cause, and massage of the neck muscles gives good results in this trouble, he believes that the muscular condition is secondary, "due to a primary nerve irritation" and says "much quicker results can be obtained by nerve vibrations."

He uses|| for "fevers or chronic headache from hyperaemia cerebri to soothe and reduce cerebral excitement,"

1. Head lifting.

2. Vibrates or works on those parts of the head demanding special attention.

3. Nerve frictions, general and also local if required.

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* Cyriax. The Elements of Kellgren's Manual Treatment, page 161.

† Ibid, page 160.

‡ Ibid, page 456.

|| Ibid, page 220.

4. Repeats head lifting.

The commonest form of this type of head exercise is as follows:

"One hand administers	Double supraorbital nerve friction or vibration, or frontal vibration. Coronal suture vibration. Sagittal suture vibration. Double parietal vibration.
"The other hand administers	Double great occipital nerve (emerges through trapezius muscle and runs upwards and outwards in the scalp) friction. Double second cervical nerve friction. Occipital suction movement. Occipital vibration movement."

Mechanical vibration may be given with the cup-shaped rubber vibratode, shortest stroke, medium rate of speed and little or no pressure over the indicated sites. It should be given for five minutes or longer.

To meet the third requirement, pelvic treatment per rectum with the static wave current and correction of constipation are often indicated.

The fourth requirement usually calls for high colonic flushings and local treatment as conditions are presented. In the vaso-motor form, intervertebral mechanical vibration with the ball vibratode between the transverse processes of the 2nd and 3rd dorsal vertebrae as indications demand for five or ten minutes with intervals of rest or d'Arsonvalization to lower blood pressure correct the arterial tension. Vibration between the 3rd and 4th dorsal vertebrae for three or five minutes dilates the pupil.

Neuritis, local, disseminated, or general, is an inflammation of one nerve or several nerves. In some cases it is occasioned by the constitutional condition of the patient, when it often occurs as a peripheral

neuritis. The pathology of neuritis may be divided into (1) parenchymatous, and (2) interstitial, in which the blood vessels and lymphatics are most extensively involved; (3) another form known as "segmental peri-axillary neuritis," in which type the normal and degenerated segments alternate. This form occurs in senility, after diphtheria and the use of toxic agents as lead.

Dana* thinks "that when there is organic disease of the nerve itself such as neuritis the disease cannot be, strictly speaking, called neuralgia." In the following the terms will be considered separately as far as possible.

Some consider neuritis as a vaso-motor nerve disease, and believe that the relief and cure depend upon the correction of the blood supply to the affected part, which is probably only true so far as any other inflammatory process might be so considered.

Sajous† states that it is "a vascular disorder of the perineural and interstitial connective tissue framework of the nerve and that the nutritional disorders of the muscles, skin, etc., are due to pressure by engorged vessels, serous effusion, etc., upon, or destruction of the nerve fibre bundles (axis cylinders) which these inflamed structures surround." When the cell bodies in the central ganglion are involved "the inflammation extends towards the cerebro-spinal axis and gradually destroys the ganglion."

The time necessary to effect a cure will vary from a few days to twelve months, or even longer, in some chronic cases.

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* Sajous. The Internal Secretions and the Principles of Medicine, page 1530.

† Sajous. The Internal Secretions and the Principles of Medicine, page 1537.

For the treatment of neuritis employ the static wave current with a flat metal electrode next to the skin over the areas of great tenderness as present about the shoulder or hips or elsewhere for twenty minutes, and then apply static sparks to all points of pain or tenderness after which use interrupted vibration with the disc vibratode at first superficially, to be followed later with deeper pressure for two or three minutes over the areas of greatest pain. The interrupted impulse should be prolonged sufficiently to relieve the pain. The spinal region corresponding to the origin and exit of the affected nerves should also be vibrated with the ball vibratode for five minutes. The exit usually requires a longer vibratory treatment, as it is usually most painful. In some chronic cases after the relief from pain an application of light vibratory friction to the affected area may be found desirable for the atrophy.

THE MODUS OPERANDI OF MECHANICAL VIBRATION when it is scientifically applied in inflammatory processes is that it relieves local stasis and promotes absorption. As the neural congestion is due to "an accumulation of toxic wastes in the blood with intestinal torpor" and consequent auto-intoxication and resultant pain from the presence of toxic wastes, indications are to remove the intestinal accumulations by colonic flushings or castor oil and correct the diet as in migraine. Water should also be partaken of freely. In the treatment of the neuralgia that so frequently accompanies neuritis, general vaso-dilatation is indicated which may be accomplished by mechanical vibration applied to the spine (see Chap. VII) or d'Arsonvalization, or by local treatment to cause constriction of the peripheral arterioles or to

cause "depletion of perineural arterioles and therefore of the endoneural capillaries."*

Hot Epsom salt baths as sometimes given in the

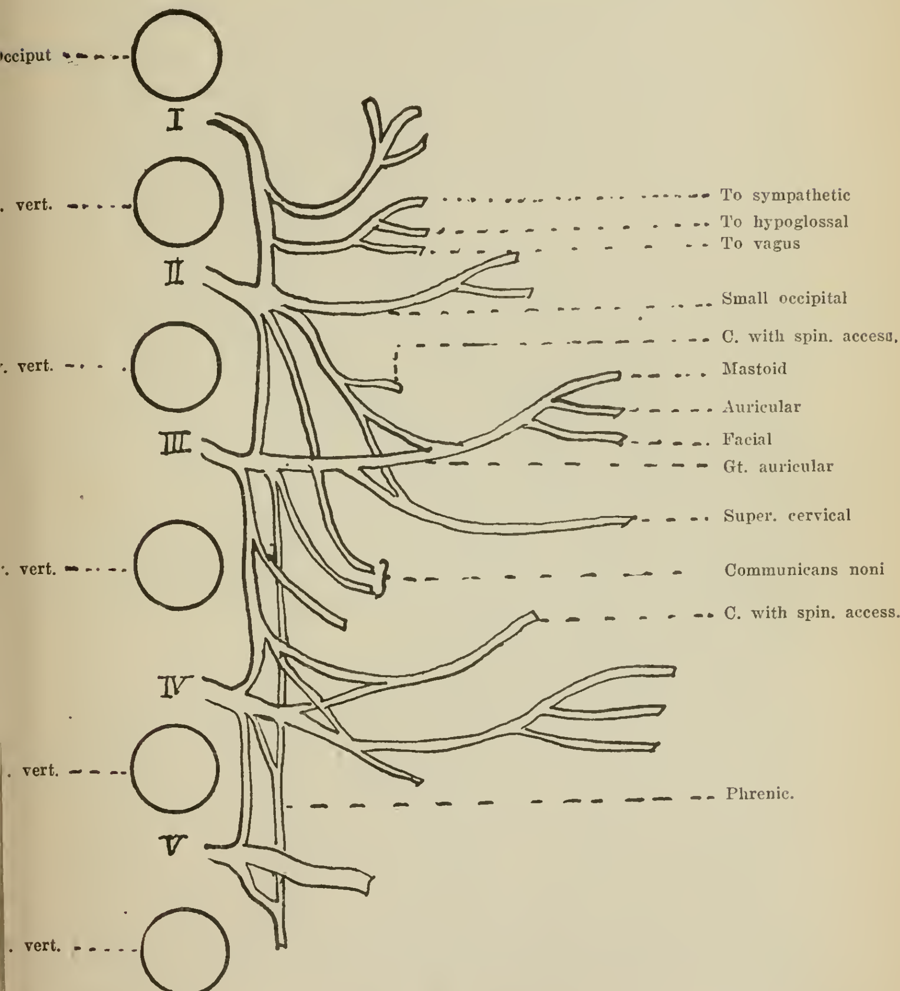

Fig. 50.—Plan of Cervical plexus with diagrammatic illustration of vertebral exits of nerves forming the same.

* Sajous. The Internal Secretions and the Principles of Medicine, page 1544.

treatment of rheumatoid arthritis prove palliative in some cases.

BRACHIAL NEURITIS is characterized by pain in the region of the shoulder with or without pain along the course of a nerve or nerves belonging to the plexus as the musculo-spiral, median, ulnar, and circumflex, and is accompanied in some cases by disorders of sensation as tingling, or areas of coldness or extreme heat. The sites of pain in the region of the shoulder are as follows: (1) the point of the shoulder, (2) a site one or one and one-half inches downward anteriorly from the superior line of the shoulder and one or more inches toward the median line, (3) the center of the scapula, (4) at the outer border of the scapula where the arm joins the body, (5) in the interscapular region, and (6) a point one or two inches above the superior border of the scapula and about two inches from the spine, and (7) just below the inferior angle of the scapula. Over the sites of the origins as well as the sites of exit of the affected nerves, tenderness is elicited.

The routine treatment consists of the application of the static wave current with a shoulder electrode or a rectangular electrode placed over the shoulder from before backward for twenty minutes, followed by static sparks to the tense muscles. Prolonged mechanical vibration follows with the ball vibratode in the intervertebral spaces over the sites corresponding with the origin and exit of the involved nerves. The most sensitive places should be vibrated the longest. A five or ten minute spinal vibration is very effective in relieving tension of the parts supplied by the affected nerves. Local vibration with the disc vibratode over the sensitive sites about the

shoulder joint is also indicated. Sometimes spinal vibration in the lower dorsal region is indicated where difficulty is experienced in raising the arm.

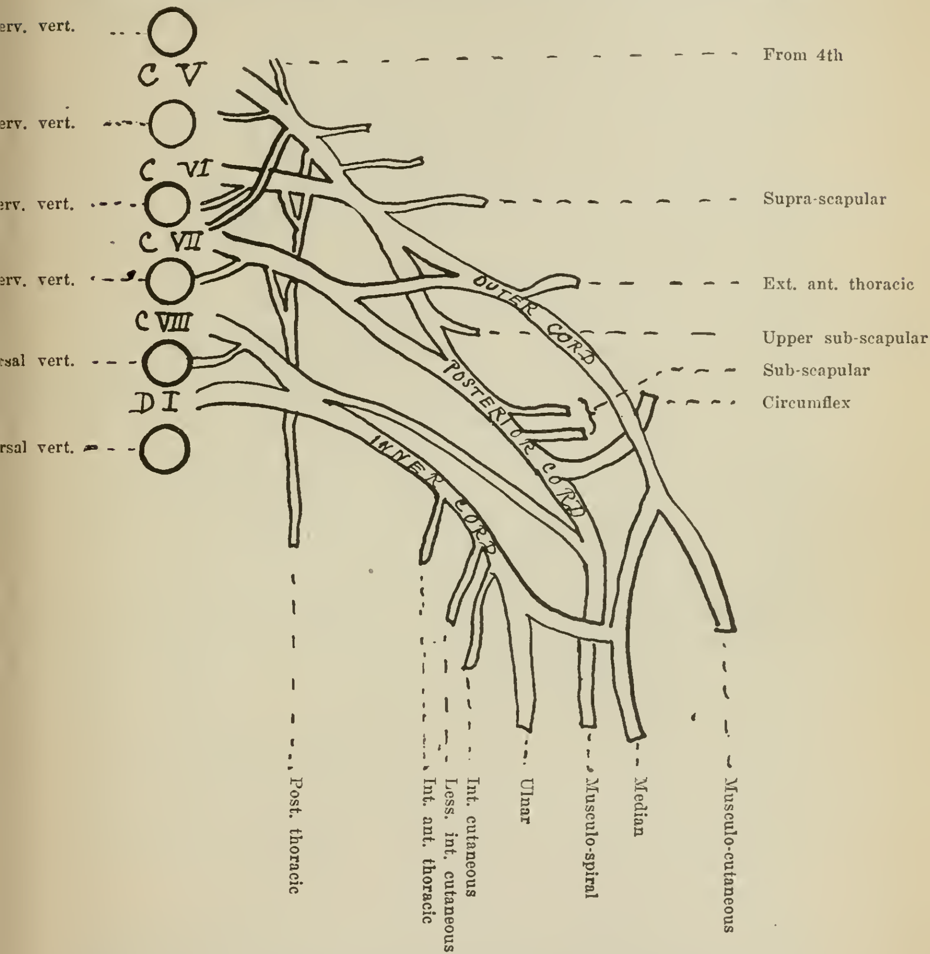

Fig. 51.—Plan of Brachial plexus with diagrammatic illustration of vertebral exits of nerves forming same.

Treatment should be at first daily, and later every other day or as the progress of the case warrants.

When treating neuritis due to an injury it should

be remembered that if a sensory nerve is affected, anaesthesia, thermo-anaesthesia or analgesia may be present, but the muscular sense is seldom lost. In cases in which septic infection is present the lightest touch of the sensitive area will elicit pain. In these cases hot air treatments are indicated.

Sciatica is a localized inflammatory affection of the sciatic nerve, manifested by pain. It is now acknowledged by authorities in all cases to be associated with a local neuritis, either involving the nerve itself or the plexus. Starr, who refers to it as a neuralgia of the nerve, states that "in all cases in which an autopsy has been obtained, an interstitial neuritis with congestion of the vessels, hemorrhages in the sheath and secondary degenerations of the nerve fibres have been found." Pain may occur in the whole or any part of the distribution of the nerve, but is generally most intense over the sacro-sciatic notch. Points of tenderness may also be found in some cases above the hip-joint (on a line with a man's hip pocket), near the posterior iliac spine, just below the crease of the buttocks, in the middle of the thigh posteriorly, the back of the knee, and posterior to the external condyle of the ankle. When a neuritis has become chronic, perverted sensations as of heat, cold, and numbness are noticeable. Intrapelvic pressure usually causes bilateral pain.

It is necessary that a careful diagnosis be made from (1) coxalgia in which pain usually first appears on the inner side of the knee and there is "a rigid position of adduction with slight rotation," (2) lesions in the cauda-equina where the trouble is almost always bilateral, and there is incontinence of faeces and urine; and (3) sacral caries characterized

by sacral tenderness, and pain on motion involving the pelvis, (4) Involvement of the sacro-lumbar cord as in Goldthwait's disease and (5) pelvic affections.

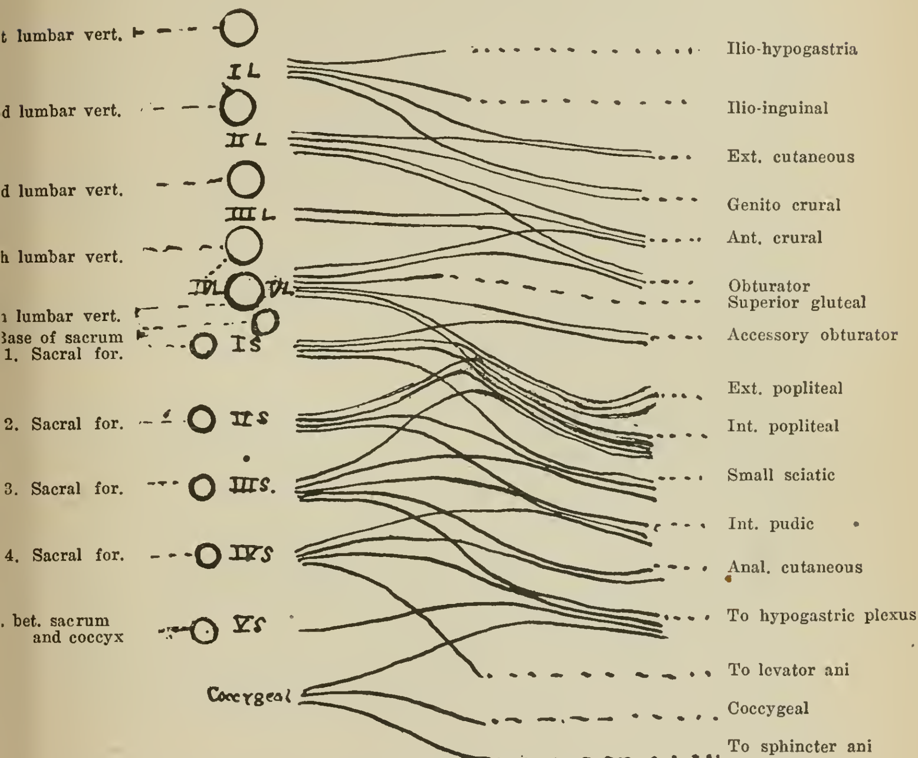

Fig. 52.—Diagram of Lumbar and Sacral plexus (after Feré) with vertebral exits of nerves of same.

The treatment of sciatica comprises the use of the static wave current applied with a flat metal electrode over the sacro-sciatic notch or higher up for twenty minutes followed if necessary, by static sparks, and mechanical vibration.

Mechanical vibratory treatment of sciatica, applied directly to the nerve trunk, is usually of

benefit. The pressure employed should be light at first. Best results are obtained if interrupted vibration is applied superficially at first, to be followed later as the pain lessens by heavier vibration administered at the sacro-sciatic notch with the disc vibratode for the purpose of producing an inhibitory effect, i.e., in cases in which the lesion is at the notch —the most common site. Prolonged vibration with the ball vibratode over the exit and origin of the affected nerve is beneficial. Interrupted vibration over the tense muscles gives comfort. Sometimes the pressure of faecal impaction causes pain in the sciatic nerve, in which case a rectal vibratory colonic flushing and spinal treatment will afford complete relief.

Double sciatica, "with chronic muscular contractures," has been reported successfully treated by Rochelle. He employed heavy vibration "over the 6th to the 12th dorsal and 5th lumbar nerves with vibration of liver and spleen anteriorly."

Sciatic neuritis should be treated to relieve the neural congestion as well as the pain as outlined under neuritis. Absolute rest is seldom essential in these cases, a limited amount of restricted exercise is usually to be preferred.

HERPES ZOSTER (shingles) characterized by intense pain along the course of the nerve, without and later with reddish patches which develop into vesicles is an intercostal neuritis with neuralgic pains where the inflammation "has advanced beyond the preliminary plasmatic hyperæmia."

The treatment if early consists of prolonged applications of radiant light and heat from a 500 candle power incandescent lamp until the affected portion

of the body is pink, this should be followed by a thorough administration of the static brush-discharge over the localized area, and the static wave current for twenty minutes over the spinal seat of the trouble followed by the prolonged application of mechanical vibration with the ball vibratode with gradually increasing pressure over the vertebral exits of the affected nerves which completes the treatment. This routine should be repeated daily until the condition is cured. Late treatment of this condition consists of the static wave current, static sparks, d'Arsonval current with two metal electrodes and mechanical vibration, spinal with the ball vibratode and local with the disc vibratode.

NEURALGIA characterized by pain is present as a symptom of neuritis usually, but not always. There are various localized pains so designated—intercostal, cervico-occipital involving the upper four cervical nerves, facial, podalgia, plantar neuralgia, gastralgia, cardialgia, nephralgia, and neuralgia of the liver, rectum, testicles, and ovaries. By some it is thought to be a peripheral disease, but most authorities regard it as not necessarily so, but a symptom due to central lesions or neuritis referred to the periphery. It presents a general constriction of the arterioles due to stimulation of the sympathetic center, followed later by relaxation of the affected arterioles due to stimulation of the vaso-motor center causing *general* vaso-constriction thereby flooding them.* In general the pain is "due to pressure upon the nervi nervorum." A nutritional disturbance of the central sensory regions is supposed to be the most fre-

* Sajous. The Internal Secretions and the Principles of Medicine, page 1540.

quent cause. Constipation or incomplete evacuations are frequently causes. If there be advanced organic disease, treatment with mechanical vibration or other mechanical measures is of little avail, for it will not relieve the pain when it is impossible to remove the cause.

The symptom may be pain together with numbness, tingling, burning, and sensitiveness, and may be also associated with automatic or reflex muscular spasms, sweating, eruptions or flushing. The pain may or may not be intermittent.

Treat the cause and if possible remove it. The treatment for neuralgia in general is the same as for neuritis.

Starr states in respect to facial neuralgia, that "vibrations maintained by a tuning-fork electrically vibrated, the end of the fork being in contact with the end of the fingers of an expert masseur, have given relief in some cases." In our experience, the use of light and a metal electrode over the surface with the static wave current for 20 minutes followed by the static brush discharge effects a cure except in cases due to diseased tissue, or carious teeth.

In treating neuralgia as a rule apply the vibratode interruptedly over the painful site or interruptedly or with friction where the nerve is nearest the surface. In the intercostal form apply it to the inferior border of the rib, i.e. of the uppermost rib at the site of the pain. The vertebral exit of the affected nerve should also be vibrated with the ball vibratode for five minutes or more as indicated to afford relief.

The site of the plexus as well as the nerve trunk should receive treatment in most cases. In employing interrupted vibration with a fairly slow rate of

speed over painful areas, apply it lightly at first, but as soon as it can be borne, gradually increase the pressure, the diminution of pain being a guide as to the increase of pressure. If deep pressure be first used the pain will cease sooner, but the treatment is not so satisfactory to the patient owing to the extreme sensitiveness of the part. The pain may gradually diminish and may cease entirely during the first treatment, but if it does not, do not persist after a reasonable length of time. As a rule treat the case daily. It may be best to treat some very obstinate or acute cases twice daily for several days until the pain is gradually subdued and then *"bridge"* accordingly.

Mechanical vibration when applied to painful areas acts not only directly but indirectly upon the nervous system as upon a special nerve as when it relaxes muscular contracture, thus relieving tension and removing pressure. Thereby the food supply of the nerve is increased, the blood pressure lowered and elimination increased. The fact has long been recognized, as noted by Snow in respect to the "Physiological Action of the Various Static Modalities." "The action upon metabolism of vibratory influence has long been recognized by physiologists, such as that attributed to the heart's impulse." Mechanical vibration improves the nutrition by overcoming local stasis, and restoring circulatory conditions. It may be a derivative measure or may be used directly over the nerve. Interrupted vibration with the rubber-covered disc, superficial, deep or compressing in character, may be used, the degree of pressure being regulated by the pain produced, i.e., as pain diminishes, increase the pressure.

What Starr has written relative to massage is applicable to administrations of mechanical vibration. He says: "*Massage* to be *useful* should be *painless*. I have seen severe injuries of nerves follow the *painful* manipulation of unintelligent masseurs and osteopaths, and the statement which such individuals often make, that if their manipulations cause pain they are thereby doing good, is absolutely false."

Longer treatments are advisable for acute than for chronic cases. Sufferers from neuralgia habitually have used firm pressure over points of tenderness or pain, which are generally in the vicinity of a joint or bony surface. Compressing interrupted vibration may likewise be applied to such points. It has been demonstrated that "light and rapid percussion temporarily aggravates pain, but *slow* and *heavy* blows set in an obtunding effect at once."

Kellogg has made use of the nerve percuter of Dr. Mortimer Granville of London in the treatment of nerves, to induce vibration, but objects to the apparatus because it gets so easily out of order. He has, however, had good results from another percuter. Granville believes "that pain is due to disharmony or morbid vibration in a nerve, and has found in his experience that acute, sharp pain is best relieved by musical vibration of a low tone (to interrupt speedy vibrations of pain), while dull heavy pain is best relieved by high-keyed vibrations (to interrupt slow vibrations of pain). He thinks that relief is obtained by interruption of the discordant nerve vibration which he considers the cause of the pain." He considers the rate of speed employed to be an important factor.

On the other hand, Dr. Pilgrim believed that "the essential factor both in the mechanical stroke and in the electric current as regards their effect on nerve tissue, is, it would seem, *intensified* natural vibration," which is a still different theory relative to vibratory effects. He said, that with certain vibration rates, amplitudes, timbres and associated rates, general sensation is influenced, and he theorized in respect to muscles that as the primary elements of striped muscle are of unequal lengths and varying degrees of tension, to induce a general contraction "several rates of oscillation" are necessary.

Time and experience will solve these problems and determine the various rates and methods of treatment and their respective status in vibratory therapeutics.

Treatment of neuralgia should include the induction of general vaso-dilatation as induced by spinal mechanical vibration, or d'Arsonvalization, or locally vibration to induce constriction of the peripheral arterioles or to deplete the perineural arterioles and therefore the endoneural capillaries. An accompanying neuritis should be treated as outlined under neuritis.

Disorders of sensation, as *paraesthesia or numbness* and *hyperaesthesia of functional character,* may often be benefited by mechanical vibratory treatment. For cutaneous *anaesthesia* use interrupted vibration with the disc vibratode employing moderate pressure. The interruptions should be very rapid. *Hyperaesthesia,* however, is most effectively treated with interrupted vibration, with the disc vibratode usually employing moderate pressure which is gradually increased and of longer duration.

NERVE CONTROL AND STIMULATION.

For the treatment of some conditions, especially those of a spasmodic nature, the following relative to the motor points of nerves, from Mosher's "Electro-Diagnosis," and sites of stimulation as well as the special functions of the nerves, or the muscles they supply based on Gray's Anatomy, Belousow-Krause's work, Kellgren's Manual Treatment by Cyriax, and Mosher's "Electro-Diagnosis" is appended. For the motor points of individual muscles see Mosher's "Electro-Diagnosis." The table in conjunction with the table of the "Action of Groups of Muscles, their Origin, Insertion, and Nerve Supply" (Chapt. VI.), will be found useful in galvanic static and high frequency work as well as in vibratory diagnosis and treatment.

NERVE.	ACTION OR MUSCLES INNERVATED.	SITE OF STIMULATION. MOTOR POINT. (M.P.)
Trifacial (trigeminus) (5th cranial)....	Elevation and forward and lateral movements of the lower jaw. Sensation—except special—to nose, ear, and eye, mucous membrane of mouth, the teeth, the skin of the head (except over the occiput). Motor supply to muscles of mastication, some of the muscles of the soft palate, the tonsil, uvula, Eustachian tube, and the digastric, mylo-hyoid, tensor tympani.	(M.P.) 1. In the sigmoid notch of the lower jaw just below the zygoma for the masseter muscle. 2. In a perpendicular line through the zygoma a finger's breadth within the border of the hair for the temporal.
A. Ophthalmic br.		
1. Frontal:		
a Supratrochlear..............	Sensation to corrugator supercilii, occipito-frontalis, and skin of forehead.	Inner side of orbit.
b. Supraorbital................	Sensation to corrugator supercilii, occipito-frontalis, orbicularis palpebrarum and skin of cranium as far as occiput.	Inner side of orbit.
2. Nasal	Sensation to mucous membrane near fore part of nasal septum and ala and tip of nose, mucous membrane of outer wall of nares to inf. spongy bones, skin of ala and tip of nose.	Lower edge of nasal bone.

B. Inf. Maxillary br.		
1. Lingual	Supplies papillae and mucous membrane of the tongue, of the mouth, the gums, and sublingual gland.	Internal to post. part of horizontal ramus of the lower jaw.
Facial (7th cranial)	Closes the eyelid and draws the face to the stimulated side. Supplies muscles of expression, and azygos uvalae, levator palati, stylohyoid, stapedius, digastric, lingualis, platysma buccinator, orbicularis oculi, occipito frontalis.	(M.P.) 1. In angle between the mastoid process and ramus of lower jaw. 2. Middle and lower branches are best stimulated in depression above the tragus. 3. For platysma, in ant. cervical triangle level with larynx.
A. Upper branch	Wrinkles the forehead and eyebrow and closes the eyelids.	(M.P.) At outer end of superciliary ridge.
1. Posterior auricular	Retracts ear and scalp	Over the mastoid process. (M.P.) Base of mastoid process level with or a little above the middle of the ear.
B. Middle branch	Laughing. Wrinkles nose and upper lip and pouts lips.	(M. P.) At meeting point of perpendicular line from outer angle of orbit with the zygoma.
1. Infraorbital	Supplies superficial facial muscles, lower eyelid, pyramidalis nasi, levator labii superioris, levator anguli oris.	As it makes its exit from infraorbital foramen.
C. Lower branch	Pouts under lip, retracts angle of mouth downward and outward, and raises chin.	(M.P.) At border of lower jaw back of groove for facial artery.
Glosso-pharyngeal (9th cranial)	Sensation to the middle ear and to mucous membrane of pharynx, fauces and tonsil. Special nerve of taste where found in tongue. Secretory fibres to parotid gland. Supplies motion to sup. and middle constrictor and stylo-pharyngeus.	Below and internal to the horizontal ramus of the jaw.

NERVE CONTROL AND STIMULATION—*Continued.*

NERVE.	ACTION OR MUSCLES INNERVATED.	SITE OF STIMULATION. MOTOR POINT. (M.P).
Pneumogastric (10th cranial)........	Motor and sensory fibres to the organs of voice and respiration and motor to pharynx, oesophagus, heart and stomach. Secretory nerve of stomach, also of kidneys (?).	Under the sterno mastoid between int. jugular vein and int. and common carotid arteries. Bend head sideways or forward to relax the muscle.
A. Sup. laryngeal....................	Supplies sensation to larynx and its ext. branch, chiefly motor, supplies crico-thyroid, inf. constrictor, and thyroid gland. Its int. br. (sensory) supplies the arytenoid muscle.	At posterior end of upper border of thyroid cartilage.
B. Inf. (recurrent) laryngeal.........	Motor nerve of larynx, supplying all its muscles except crico-thyroid.	Low down at side of trachea.
Spinal accessory (11th cranial). (Sensory fibres from first seven post. roots of sup. cervical nerves.)	Extends head. Elevates and rotates chin toward opposite side. Supplies trapezius, sterno cleido mastoid. Stimulation of the spinal accessory causes contraction of muscles of larynx and upper part of oesophagus. Accessory fibres in vagus inhibit heart when stimulated.	Behind sterno-mastoid at middle of its border posteriorly. (M.P.) About an inch below upper angle of post. cervical triangle, near the trapezius.
Hypoglossal (12th cranial). (Communicates with 1st, 2nd, and 3rd cervical nerves.)	Movements of tongue. Supplies by fibres from upper four cervical nerves thyro-hyoid, sterno-hyoid, genio-hyoid and omo-hyoid.	(M.P.) Close behind and above the hyoid bone.

Cervical Nerves:		
A. 1. (Ext. br. of post. division of cervical nerves.)	Draw the head backward and downward. Recti, obliqui, and complexus supplied by 1st c. nerve which sometimes does not divide into two branches, inf. oblique supplied by 2nd c. before it divides. The 2nd (ext. br.) and 3rd (ext. br.) supply splenius, complexus and trachelo mastoid. The 3rd supplies the skin on the lower and back part of the head. The 4th, 5th, 6th, 7th, and 8th (ext. br.) supply muscles at side of neck,—cervicalis ascendens, transversalis colli, trachelo mastoid.	(M.P.) Over belly of splenius capitis close under mastoid process, for splenius capitis;
2. Great occipital. (Int. branch of post. division of 2nd c. nerve.)	Supplies sensation to skin of scalp as far as vertex. Supplies complexus, splenius, trachelo-mastoid.	Where it emerges through trapezius and ascends on back part of head.
B. Cervical plexus. (Ant. division of four upper cervical nerves.)	Superficial branches, from 2nd and 3rd c. nerves supply platysma. Supplies anterior recti, and rectus lateralis from 1st c. nerve. Supplies sterno mastoid from 2nd c., levator anguli scapulae and trapezius from 3rd and 4th c, and scalenus medius through 3rd or 4th.	
1. Phrenic. (Ant. div. of 3rd, 4th, and 5th c. nerves, particularly the 4th.)	Ballooning of epigastrium and noisy rush of air into air passages. Innervates diaphragm. Sensory fibres for pleura, pericardium and peritoneum.	(M.P.) Behind edge of sterno-cleido-mastoid between the upper and middle thirds, sometimes farther below (push vibratode beneath the muscles).
2. Small occipital. (Desc. branch of ant. div. of 2nd c. nerve.)	Innervates skin over the mastoid process and ramifies in skin of occipital region.	Over the mastoid process.
C. Fourth cervical nerve............	Nerve root of supraspinatus and teres minor. (Thorburn.)	

NERVE CONTROL AND STIMULATION—*Continued.*

NERVE.	ACTION OR MUSCLES INNERVATED.	SITE OF STIMULATION. MOTOR POINT. (M.P.)
D. Fifth cervical nerve..............	Nerve root of biceps, brachialis anticus, deltoid, supinator longus, supinator brevis (?). (Thorburn.)	
E. Sixth cervical nerve..............	Nerve root of subscapularis, pronators, teres major, latissimus dorsi, pectoralis major, triceps, and serratus magnus. (Thorburn.)	
F Seventh cervical nerve............	Nerve root of extensors of wrist. (Thorburn.)	
G. Eighth cervical nerve............	Nerve root of flexors of wrist. (Thorburn.)	
H. Dorsalis scapulae (3rd, 4th, 5th c. nerves).	Elevates and draws the shoulder blade toward the median line.	(M.P.) In middle of post. cervical triangle about one and one-half inches above clavicle.
Brachial Plexus. (Ant. branches of 4 lower c. and 1st d. nerves.)	Flexion of hand and fingers. Elevation of arm from thorax, etc.	Post. triangle in front of trapezius. (M.P.) Lower part and inner one-third of supraclavicular fossa.
A. Supra scapular (5th and 6th c. nerves).	Rotates humerus. Supplies supraspinatus, infraspinatus (which assist in rotation outward at shoulder joint), shoulder joint and scapula.	Supra and infraspinatus muscles. (M.P.) Infra spinous fossa and near outer angle of supra spinous fossa (only when atrophy of trapezius).
B. Post. or long thoracic (5th, 6th and 7th c. nerves).	Moves shoulder blade out and forward. Supplies serratus magnus.	(M.P.) In front of border of trapezius just above clavicle. For serratus magnus in mid. axillary line, especially at 6th rib.

C. Ant. thoracic (5th, 6th, 7th, and 8th c. and 1st d. nerves).	Adducts arm to thorax. Supplies pectoral muscles.	Over pectorals. (M.P.) Below clavicle at upper border of pectoralis major or behind and above clavicle at outer border of sterno-cleido-mastoid.
First dorsal nerve..................	Nerve root of interossei and other intrinsic muscles of hand.	
Erb's supra clavicular point. (Represented by muscles whose nerve root is the 5th or 6th (?) c. nerve, deltoid, biceps, brachialis anticus, supinator longus.)	Draws arm back from thorax and elevates it. Flexion at elbow in position of pronation.	(M.P.) One inch above clavicle and half an inch behind border of sterno-cleido-mastoid.
D. Subscapular (5th, 6th, and 7th c. nerves).	Lower subscapular rotates humerus. Long subscapular adducts arm backward and downward. Rotates humerus inward.	(M.P.) Teres major (lower subscapular) in axilla (sometimes). Ant. border of latissimus dorsi (long subscapular) on a line with angle of scapula.
E. Circumflex (5th, 6th, and 7th c. nerves).	Raises arm backward from trunk................	Over the deltoid. (M.P.) Middle of post. triangle one inch above clavicle.
F. Musculo-cutaneous (5th, 6th, and 7th c. nerves).	Flexion of the forearm by biceps and brachialis anticus. Biceps is also a supinator. Coracobrachialis draws humerus forward and inward. and elevates it toward the scapula.	(M.P.) One inch below ant. axillary fold at inner border of biceps.

NERVE CONTROL AND STIMULATION—*Continued.*

NERVE.	ACTION OR MUSCLES INNERVATED.	SITE OF STIMULATION. MOTOR POINT. (M.P.)
G. Median (5th, 6th, 7th, 8th c. and 1st d. nerves).	Pronator radii teres and pronator quadratus (ulnar and median) rotate the radius on the ulna, and render the hand prone. When pronation has occurred, the pronator radii teres assists the other muscles to flex the forearm. Flexion of the wrist by flexor carpi radialis with ulnaris (ulnar). Flexion of second and last phalanges by flexor sublimis and flexor profundus digitorum (ulnar and median). Flexion of last phalanx of thumb by flexor longus pollicis (ulnar and median). Innervates muscles of thenar eminence except adductor transversus and adductor obliquus. Sensory fibres to palm of hand, and ant. surface of thumb, index, second and middle fingers and radial side of fourth finger.	1. In axilla. 2. Internal to biceps. 3. At elbow joint in middle line. 4. In forearm in middle line. (M.P.) 1. In middle of elbow joint usually just external to biceps tendon. 2. In middle of wrist joint between tendons of palmaris longus and flexor carpi radialis.
1. Ant. interosseous..........	Supplies deep muscles of front of forearm except part of flexor profundus digitorum. Supplies flexor longus pollicis, a part of flexor profundus digitorum and pronator quadratus.	About two or two and a half inches above wrist on radial border.
H. Ulnar (8th c. and 1st d. nerves)..	Ulnar flexion of hand and 1st phalanges of fingers. Adducts thumb. Abducts and flexes little finger. Supplies sensory fibres to palm and part of ant. digital surfaces not supplied by median nerve and part of dorsum of hand.	1. In axilla internal to axillary artery. 2. Along inner border of biceps. 3. At elbow joint in groove behind inner condyle. 4. Ulnar side of forearm. (M.P.) 1. A finger's breadth above inner condyle between the inner condyle and the olecranon. 2. Slightly above the wrist, ulnar side.

I. Musculo-spiral (5th, 6th, 7th, 8th c. and 1st d. nerves).	Extension of forearm, wrist, hand and fingers with supination. Sensation to dorsal part of forearm and hand, and a part of the arm over brachialis anticus.	1. Between int. and ext. heads of biceps. 2. Between brachialis anticus and supinator longus. (M.P.) External to point between external condyle and insertion of deltoid.
1. Radial.	Thumb and part of fingers	Along inner border of supinator longus in upper part of forearm when forearm is flexed and quickly pronated.
2. Post. interosseus	Action as indicated by names of muscle supplied. Supplies ext. carpi radialis brevior, supinator brevis, ext. carpi ulnaris, ext. communis digitorum, ext. minimi digiti, ext. ossis metacarpi pollicis, ext. primi, and ext. secundi internodii poll., and ext. indicis.	1. Back of forearm. 2. In supinator brevis, forearm being flexed and pronated.
Intercostal nerves.		
A. 1. Upper intercostal nerves. (Ant. br. upper six dorsal nerves.)	Movements of ribs. Serratus posticus sup. Partly levatores costarum breves.	Ant. cutaneous branches near outer edge of sternum where they emerge. (M.P.) On upper border of intercostal spaces.
2. Lower intercostal nerves. (Ant. br. lower six dorsal nerves.)	Retraction of abdomen. Supply integument of chest and abdomen and front of the hip.	(M.P.) 1. Below umbilicus along outer border of rectus abdominis for this muscle. 2. Over belly of obliquus ext. abdominis for the obl. ext. abd.
B. Post. br. dorsal nerves	Assist in keeping spine erect, in rotating the spine, and also assists in bending the trunk backward. Sensory fibres to skin of back.	Where they pass through the erector muscles of the spine near the median line, the points of emergence of the last two or three lying more externally.
A. Lumbar nerves. (Post. div. of lumbar nerves.)	Assist in keeping spine erect, bending the trunk backward and rotating it.	Where they exit which diverges from above downward. The lowest are four inches from the posterior median line.

NERVE CONTROL AND STIMULATION—*Continued.*

NERVE.	ACTION OR MUSCLES INNERVATED.	SITE OF STIMULATION. MOTOR POINT. (M.P.)
B. Lumbar plexus. (Ant. br. of first four lumbar nerves.)	Supplies int. obl., transversalis, quad. lumborum, cremaster, muscles of hip and thigh, except those on posterior part. Supplies sensation to ant. part of thigh limited by outer border of biceps and inner border of semitendinosus, skin of loins, ext. genitals and anteriorly on the leg between the outer border of tendon Achilles and middle of inner head of gastrocnemius to outer border of tibialis anticus.	
1. From the 1st lumbar nerve...	Quadratus lumborum. Psoas is supplied by ant. br. of lumbar nerves. The quadratus lumborum assists in forced expiration, and in inspiration. It inclines trunk to its own side. If spine and thorax fixed, it flexes pelvis to its own side. The two quad. lum. muscles together flex the trunk. Psoas and iliacus (ant. crural) acting from above, flex thigh on pelvis and rotate femur outward; acting from below, femur being fixed, muscles from both sides bend lumbar part of spine and pelvis forward; assist in raising the trunk when body is recumbent. Maintain erect position.	
2. Ilio-hypogastric. (Ant. div. of 1st lumbar nerve.)	Supplies int. and ext. oblique partly. Assist in compressing abdominal viscera, if pelvis and thorax are fixed. If thorax is fixed, they assist in drawing the pelvis upward as in climbing.	Near crest of ilium

3. Ilio-inguinal. (Ant. div. of 1st lumbar nerve.)	Supplies int. and ext. oblique partly............	In inguinal canal.
4. Ext. cutaneous. (Ant. div. of 2nd and 3rd lumbar nerves.)	Supplies skin along ant. and outer part of thigh to knee and posteriorly from crest of ilium to middle of thigh.	Below ant. superior spine in upper third of thigh.
5. Genito-crural. (Ant. div. of 1st and 2nd lumbar nerves.)	Supplies cremaster muscle and part of skin on ant. part of thigh, as far as half way between the pelvis and the knee.	
6. Obturator. (Ant. div. of 2nd, 3rd and 4th lumbar nerves.)	Adducts the thigh. Assists ext. rotators in rotating the thigh outward.	Along adductor muscles. (M.P.) At outer end of horizontal ramus of pubis.
7. Accessory obturator. (From obturator or from 3rd and 4th, possibly 2nd lumbar nerves.)	Supplies pectineus partly and hip joint.	
8. Anterior crural. (Ant. div. of 2nd, 3rd and 4th lumbar nerves.)	Extends leg. For action of psoas and iliacus see 1 lumbar nerves.	At Poupart's ligament between psoas and iliacus. (M.P.) 1. Above and behind middle of Poupart's ligament. 2. In Scarpa's triangle to the outer side of femoral artery.
Sacral Plexus. (Ant. div. of 1st, 2nd and 3rd sacral nerves with the lumbo-sacral cord.)		
A. Superior gluteal. (Lumbo-sacral cord, 4th and 5th lumbar.)	Abduction of thigh. Rotates thigh inward.......	Two inches below crest of ilium. (M.P.) Between the trochanter major and the crest of the ilium for gluteus medius.
B. Inferior gluteal (br. of small sciatia?). (Lumbo-sacral cord and 1st and 2nd s. nerves.)	Assists in extension, abduction, and outward rotation of thigh. Elevation and adduction of buttock. Supplies hip joint, obturator internus, and gluteus maximus.	Inner side of the buttock. (M.P.) Over belly of glutus maximus.

NERVE CONTROL AND STIMULATION—*Continued.*

NERVE.	ACTION OR MUSCLES INNERVATED.	SITE OF STIMULATION. MOTOR POINT. (M.P.)
C. Small sciatic. (Usually from lower part of sacral plexus.)	Sensory nerve to skin over gluteal region and leg, perineum and scrotum.	At junction of buttocks with thigh.
D. Great sciatic. (The four roots of sacral plexus.)	Flexes leg. Plantar flexion of foot..............	Middle of back of thigh. (M.P.) Half way between great trochanter and tuberosity of ischium in gluteo femoral crease or just below it.
1. Ext. popliteal nerve.........	Dorsal flexion of foot and extension of toes, through its branches.	With flexed knee, behind head of fibula at inner border of tendon of biceps. (M.P.) At outer angle of popliteal space close to inner border of tendon of biceps.
a. Ant. tibial............	Flexes tarsus upon the leg, raises inner border of foot. Peronei draw outer border of foot up, and sole outward. Ext. prop. poll. and ext. long. dig. extend phalanges of toes. Supplies adj. sides of 1st and 2nd toes on dorsum.	Between tibia and fibula at outer edge of tibialis anticus.
b. Musculo-cutaneous	Supplies peroneus longus, and brevis and innervates skin over dorsum of foot. Everts foot, (with peroneus tertius?). Innervates skin over dorsum of foot. Supplies 1st, 2nd, 3rd, 4th and 5th toes on dorsum of foot except outer side of little toe (from ext. saphenous from int. popliteal) and adjoining sides of 1st and 2nd toes (from ant. tibial).	Between peronei when stimulated high up.

2. Int. popliteal................	Wrinkling of skin of sole and flexion of sole and plantar flexion of toes. Popliteus raises the heel in walking and assists in flexing leg upon thigh. Tib. post. assists in extending tarsus upon leg and with tib. ant. turns sole of foot inward.	With knee flexed at right angles, in middle of popliteal space. (M.P.) Just above middle of popliteal space.
a. Posterior tibial.........	....	In the middle line at back of calf or behind int. malleolus.
a′. Int. plantar................	Supplies abductor pollicis, flex. brevis digitorum, flexor brevis pollicis, 1st and 2nd lumbricales. Supplies 1st, 2nd, 3rd, and part of 4th toes on plantar surface.	Outer side of abductor hallucis.
b′. Ext. plantar................	Supplies flexor brevis digitorum and flexor accessorius, opponens minimi digiti and 2nd, 3rd, and 4th interosseous muscles, adductores obliquus transversus pedis and flexor brevis hallucis. Supplies 5th and part of 4th toe on plantar surface.	Obliquely across foot from within outwards.
Pudic plexus or nerve (4th and 5th sacral nerves). Some say from sacral plexus.	Motor nerve to muscles of perineum, anus and lower part of rectum, and sensation (partly) to skin of perineum and ext. genitals.	Between inf. border of pyriformis and tuberosity of the ischium.
Coccygeal nerve....................	Saccro coccygeus muscle and also to hypogastric plexus (Symp.). Supplies skin of coccygeal region.	Post. part of coccyx.

THERMOVIBRASSAGE has been used by Hitchings* in the treatment of neuralgia as well as bruises, sprains and other conditions. "A resistance coil is inserted into the same space ordinarily occupied by a ball vibratode. The case surrounding the coil is of metal, and screws on the vibrator shaft just as an ordinary vibratode screws on. From a plug switch on the bale of the vibrator a short cable passes into the case to connect with the coil wires, and part of the current which runs the vibrator is shunted through the coil circuit at pleasure by turning a switch on the bale beyond the plug switch, but between the switch controlling the current supply for the vibrator motor and the latter." If the heat switch is turned on for thirty seconds, after the vibrator is running, and if it is then turned off in the following thirty or forty seconds, a temperature of about 108° F. will result. Treatment is begun at this temperature. The heat switch is turned on again for ten to twenty seconds and the temperature is raised. Vibration continues whether the heat switch is on or off. His report is as follows: The patient had suffered for years from attacks of trifacial neuralgia. "No particular exciting cause had ever been found after repeated examinations. Different forms of treatment had been tried with little or no result. Dry thermovibrassage as hot as could be borne with comfort, was given over the tender spot, painful areas, and neck for five minutes. The pain stopped completely before the treatment was over, and the patient felt drowsy, and took a nap. There was no

* Thermovibrassage, A New Method of Treatment. Journal *A. M. A.*, October 27, 1906.

return of the pain until another attack came on three weeks later."

While treating of neuralgia a consideration of the subject of "REFERRED PAIN," of which Head, Dana, Schmidt, Butler and others have made a scientific study, is important.

Head's explanation of the phenomena is that a stimulus to an internal organ causing pain induces centripetal impulses, which are generally below "the threshold of consciousness," to be carried to a particular spinal segment. A disturbance which may be local but is usually diffused occurs here in which are involved some fibres connecting this same segment with a definite area of the surface of the body. Sensation and localization are more highly developed in the skin than in the viscera so that consciousness refers the pain to a definite surface of the body instead of the affected viscera.

Mackenzie believes that the pain in visceral disease is "not felt as such in the organ, but is referred to the peripheral distribution of the cerebrospinal nerves in the external body wall. Through an error of subjective localization the sensation is then interpreted as having its site in some adjoining internal structure, for example the stomach in gastric ulcer, or the heart in angina pectoris."

Starr says, "They are referred by consciousness not to their actual point of origin, but to the part of the body from which sensations usually come when received at the particular segments irritated."

As given by Starr:

"The pain in eyestrain may be felt in the forehead or in the back of the neck.

"The pain* produced by decayed teeth may be felt in the *temple* or *behind the ear,* instead of in the jaw. Severe pain *in the back* of the head is a common symptom of uterine disease or of inflammation of the bladder.

"Pain *down the left arm* is a common symptom of ear disease, and may be attended by hyperæsthesia in the region of the fourth and fifth dorsal nerves on the chest.

"Pain *in the wrist* on the flexor surface is frequently felt in disease of the uterus, ovaries or bladder.

"Pain *under the right shoulder blade* is common in enlargement of the spleen.

"Pain *between the shoulder blades* is a very common symptom of gastric affections of any kind. It may be attended by hyperæsthesia in the epigastric region, and the nearer the disease to the cardiac end of the stomach, e.g., ulcer, the higher the pain is felt. In severe vomiting pain may be felt *on the back of the arms* or even down the back of the forearms.

"Pain *across the small of the back* is common in colitis or in impaction of the fæces within the colon.

"Pain *across the upper sacral region* is very common in uterine disease.

"Pain *over the outer side of the hips* is usually due to ovarian congestion.

"Pain *down the inner side of the legs* is also due to the same cause.

"Pain *down the inner side of the knee* is an early symptom of hip-joint disease.

* Starr. Organic Nervous Diseases, page 100.

"Pain *in the heel* is a frequent symptom in lithæmia, and may also be felt in ovarian diseases."

According to the same authority regions of referred pain after Dana are:

"*Cerebro-Spinal Nerves.*	*Distribution.*	*Associated ganglia of sympathetic*	*Distribution*
I. Trigeminus facial.	Face and anterior scalp.	4th cerebral.	Head.
II. Upper 4 cervical.	Occiput, neck......	1st cervical........	Head, ear.
III. Lower 4 cervical and 1st dorsal.	Upper extremity....	2d and 3d cervical, 1st dorsal.	Heart.
IV. Upper 6 dorsal...	Thorax.............	1st to 6th dorsal....	Lungs.
V. Lower 6 dorsal...	Abdomen upper lumbar.	6th to 12th dorsal..	Viscera of abdomen and testes.
VI. 12th dorsal and 4th lumbar.	Lumbar region, upper gluteal, anterior and inner thigh and knee.	1st to 5th lumbar...	Pelvic organs.
VII. 5th lumbar and 5 sacral.	Lower gluteal, posterior thigh and leg.	1st to 5th sacral....	Pelvic organs and legs."

The general principle for treating these conditions is to vibrate the spinal centers and treat the functional or organic disorder present. Starr noted that sharp counter-irritation where the pain is will frequently improve the condition of the viscus as well as relieve the pain. This agrees with the results obtained from the administration of other modalities. Reed* in considering visceral pain and its expression in superficial muscle or muscles states that "the pain itself can be partially and, as a rule, entirely, inhibited by inhibiting the muscle sensibility in the hyperalgetic areas."

James Ross suggested that the pain is in such cases referred to parts supplied by sensory cutaneous nerve fibres, ending in the same segments of the cord as do the afferent fibres of the viscus diseased. "Referred pain will occur in the skin areas of those roots which have white rami, of those from which the pelvic nerves arise, and of those nerves, if any, with which the vagus afferent fibres are intimately con-

* The Autonomic Manifestation and Peripheral Control of Pain Originating in the Uterus and Adnex. *Jour. A. M. A.*, Mch. 25, 1911.

nected. And there should not be primary referred pain in any other skin areas." Quincke made a study of sympathetic sensations.

According to Schäfer the "earliest attempt to determine which spinal nerves innervate a given abdominal viscus was made by Bulgak in 1877." Other investigators were Bradford, Bechterew, Mislawsky, Bayliss, Starling, Schäfer and Moore.

AREAS OF REFERRED PAIN AND TENDERNESS IN AFFECTIONS OF THE HEAD AND NECK.

(HEAD)

Organ Involved.	*Maximum Point of Referred Pain and Tenderness.*
Ciliary muscle (disorders of accommodation)	Midorbital.
Cornea	Frontonasal.
Iris	Fronto-temporal, temporal, and maxillary.
Vitreous body (Glaucoma)	Temporal.
Retina	Vertical.
Tympanic membrane	Hyoid.
Middle ear	Vertical and behind the ear.
Upper teeth	Frontonasal, nasolabial, temporal, maxillary, or mandibular.
Lower teeth	Mental, hyoid, superior laryngeal, and in the ear.
Tongue, anterior part	Mental.
Tongue, lateral part	Hyoid, superior laryngeal, and in the ear
Tongue, posterior part	Superior laryngeal hyoid, occipital.
Tonsil	Hyoid and in the ear.
Nose, olfactory portion	Frontonasal and midorbital.
Nose, respiratory portion and posterior nares	Nasolabial (occasionally).
Larynx	Superior and inferior laryngeal (in destructive lesions).

ASSOCIATED PAINFUL AREAS ABOUT THE HEAD RELATED TO VISCERAL DISEASE.

(HEAD)

Area on Body.	*Associated Areas on Head.*	*Organs in Particular Relation with these Areas.*
Cervical 3 and 4	Fronto-nasal	Apices of lungs, stomach, liver, aortic orifice (?).
Dorsal 2 and 3	Mid-orbital	Lungs, heart, arch of the aorta.
Dorsal 4	Doubtful	Lung.
Dorsal 5	Fronto-temporal	Lung and occasionally the heart.
Dorsal 6	Fronto-temporal	Lower lobe of lung and heart.
Dorsal 7	Temporal	Bases of lungs, heart, and stomach.
Dorsal 8	Vertical	Stomach, liver, and upper part of the small intestine.
Dorsal 9	Parietal	Stomach, and upper part of the small intestine.
Dorsal 10	Occipital	Liver, intestine, ovary and testicle.

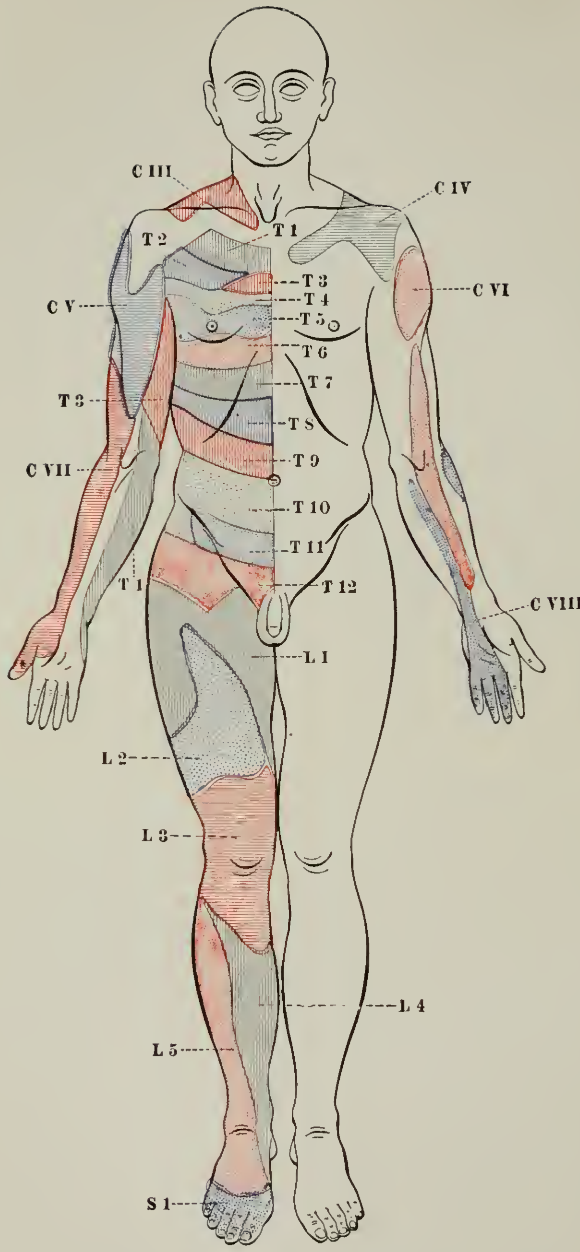

PLATE IX.—Diagram of Skin Areas Corresponding to the Different Spinal Segments. Combined from Head's diagrams by Osler.

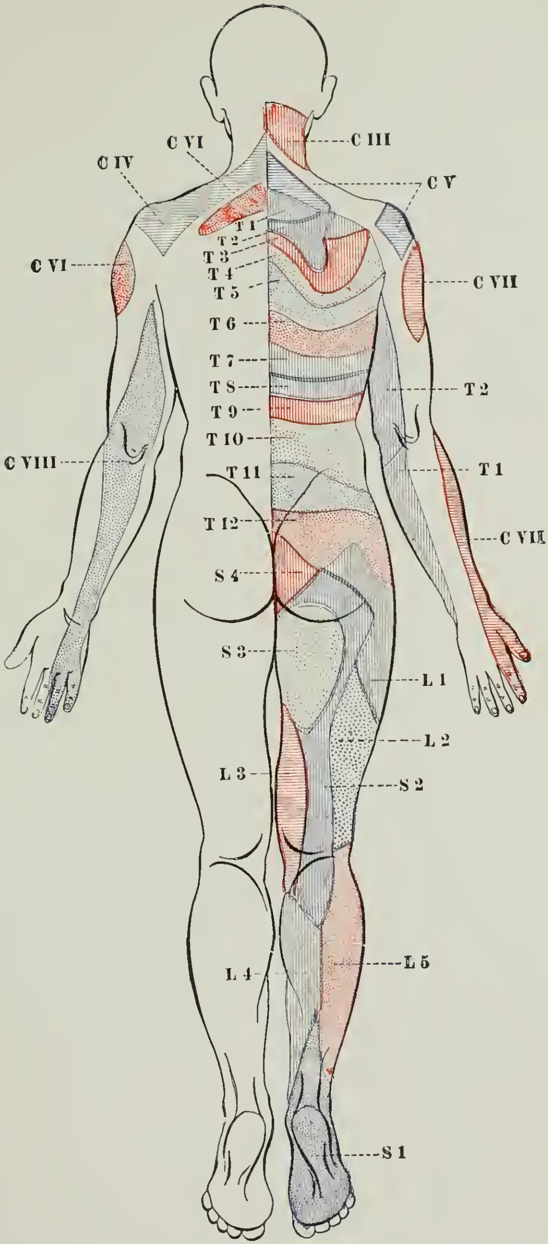

PLATE X.—Diagram of Skin Areas Corresponding to the Different Spinal Segments. Combined from Head's diagrams by Osler.

SEGMENTAL DISTRIBUTION OF REFERRED PAIN AND TENDERNESS IN VISCERAL DISEASE.

(COMPILED FROM HEAD)

Organ Involved.	*Area on Body.* (Segment)
Heart	Cervical 3. Dorsal 1, 2 and 3.
Lungs	Cervical 3 and 4. Dorsal 1 to 9 (sometimes 10 especially Dorsal 3, 4 and 5)
Breast	Dorsal 4 and 5.
Oesophagus	Dorsal 5, 6 and 8.
Stomach	Cervical 3 and 4. Dorsal 6, 7, 8 and 9.
Stomach (Cardiac end)	Dorsal 6 and 7.
Stomach (Pyloric end)	Dorsal 9.
Intestines (down to upper part of rectum)	Dorsal 9, 10, 11 and 12.
Intestines (rectum)	Sacral 2, 3, and 4.
Liver and bladder	Dorsal 7, 8, 9 and 10. . (perhaps 6).
Kidney and Ureter	Dorsal 10, 11 and 12. The nearer the lesion lies to the kidney, the more the pain and tenderness is associated with the 10th dorsal segment. The lower the lesion in the ureter, the more the 1st lumbar tends to appear.
Bladder (mucous membrane and neck).	Sacral 1, 2, 3 and 4.
Bladder (overdistension and ineffectual contraction).	Dorsal 11 and 12. Lumbar 1.
Prostate	Dorsal 10, 11 and 12. Lumbar 3. Sacral 1, 2 and 3.
Epididymis	Dorsal 11 and 12. Lumbar 1.
Testis	Dorsal 10.
Ovary	Dorsal 10.
Uterine Appendages	Dorsal 11 and 12. Lumbar 1.
Uterus (in contraction)	Dorsal 10, 11 and 12. Lumbar 1.
Uterus (Os uteri)	Sacral 1, 2, 3, 4, very rarely Lumbar 5.

HYSTERIA is a functional neurosis. It is due to auto-intoxication, mental strain, pelvic disorders, or some agent increasing the arterial tension with resulting hyperæmia of the nervous elements* of the posterior pituitary body causing hyperæsthesia of its centers, characterized by lost control, either mental or physical or both, and marked by varying degrees of anaesthesia, paralysis, contractions, or other perverted conditions which call for removal or treatment of the cause. An examination of most of the patients elicits a tenderness of the uterus which is in most cases successfully treated by daily applications of the static wave current to the uterus per rectum for twenty minutes. Amenorrhoea may be relieved by a combined static and mechanical vibratory treatment for lowering the tension and to promote increased elimination and better functional

* Sajous. The Internal Secretions and the Principles of Medicine, page 1862.

activity. These patients should have careful psychic, dietetic, and hygienic management. If environment is not conducive to best results, a change where strict enforcement of prescribed routine treatment can be enforced is beneficial. Sun light, daily baths, outdoor exercise, outdoor sleeping, when possible, colonic flushings of one quart of saline solution 110° F., twice a week, and a non-auto-intoxicating diet but nutritious are recommended. Sajous believes that saline enema "increase the fluidity of the blood and inhibit the irritability of the centers in the posterior pituitary body." It is absolutely necessary in conjunction with mechanical vibratory treatment that moral restraint and control should dominate these patients. Tact, firmness and removal of local conditions that are apt to influence the affection are of prime importance, and call for careful investigation in every case. In addition to these, a spinal vibratory treatment with the ball vibratode applied to the intervertebral spaces for a general constitutional effect and to lower blood pressure is indicated in most cases. Sometimes a general vibratory treatment meets other conditions. Regulated exercise and static electricity are valuable adjuncts. A rubber-covered disc vibratode applied to the areas of anaesthesia with rapid interruptions is beneficial as are also static sparks. The treatment of disordered sensory symptoms is of secondary importance.

Neurasthenia is a neuropathic condition which, according to Snow, "partakes in every case of some functional or organic derangement which either may have been primarily the cause of the nervous exhaustion or has resulted from it." There is exhaustion of the sympathetic center as pointed out by Sajous

and with a consequent "relaxation and loss of propulsive activity* of the arterioles." Lessened rapidity of the blood flow causes lessened functional activity of the organs, in consequence of which there is a lack of power generally,—organically, mentally and physically. The relaxed arterioles cause larger quantities of blood to go to the capillaries, thus they become engorged and the resulting effects are pain, tenderness, insomnia, indigestion, an alteration of secretory and excretory functions, dysmenorrhea, false angina caused by engorgement of the cardiac capillaries, anaemia and associated conditions—tending to hysteria or hypochondriasis. The first indication is to remove or treat the cause.

Mechanical vibration induces functional activity without the expenditure of active energy on the part of the patient. Constitutional vibratory treatment, however, will be of little value unless the cause for the condition be treated and relieved. The capillary congestion should be removed and nutrition should be promoted. In the treatment of this condition apply interrupted vibration to the spine with the ball vibratode, special regions being vibrated to meet conditions. Also treat according to indications any local condition associated with the trouble. In all cases stimulate the liver, spleen and solar plexus to awaken sluggish activities. In some cases a more general treatment may be indicated. Conditions must be met as found in individual cases. Treatments include the following as Snow† aptly says: "Radiant light and heat and mechanical vibration as

* Sajous. The Internal Secretions and the Principles of Medicine, page 1866.

* Wm. Benham Snow. Currents of High Potential of High and Other Frequencies, page 209.

indicated: d'Arsonvalization for the treatment of hypertension when present and the static and high frequency currents in the treatment of the two types of pelvic inflammation, simple and infected, each ploys an important rôle." Hygiene including daily baths, outdoor life to a great extent passive and life at the seashore are beneficial. Sea bathing is recommended when not contraindicated by the patient's condition. A restricted non-fermentative but nutritious diet is necessary, and environments as far as possible should be made congenial. The length of time necessary to treat an individual case, and the prognosis will depend upon the chronicity, whether organic disease be present, and on how amenable the cause is to treatment. For gastroptosis or displacements of other abdominal viscera, the use of a proper corset or abdominal belt is beneficial in conjunction with indicated treatment. They afford support and favorably affect the abdominal circulation.

Sexual neurasthenia, impotency and prostatitis may also be treated by mechanical vibration either alone or in connection with applications of static electricity. Employ the rectal vibratode for five minutes or so, using a medium stroke and a fairly rapid speed, taking care that the treatment be not too prolonged. The best vibratode, in the writer's opinion, is a flexible one of soft rubber about six inches long. The application has a soothing effect and is not disagreeable to the patient. As yet little has been published in this line of treatment, but it offers a splendid field for rational investigation. The treatment par excellence for this condition according to Snow* is by static electricity.

* Wm. Benham Snow. Currents of High Potential of High and Other Frequencies, page 218.

Splanchnic neurasthenia (Abrams) characterized by nervous depression "abdominal sensitiveness, tenderness and enlargement of the liver, gaseous accumulations in the bowels and an exaggerated cardio-splanchnic phenomena" has been considered in Chapter VII. Spinal vibratory treatment is indicated from the 5th to the 12th dorsal nerves inclusive, whose origins are from the 2nd to the 9th dorsal vertebra inclusive. (Morris.)

Chorea is caused by (1) waste products due to waste from excessive metabolism, or the result of hypocatabolism, (2) toxins of infectious disease, or (3) autotoxins,"* inducing over excitability of the vaso-motor center and causing general vaso-constriction (of the large vessels) and consequent abnormal functional activity and increased arterial tension. The indications are met by reducing the waste products by high colonic saline solution flushings, one quart, 110° F. twice a week and the use of castor oil, and mineral waters. Light baths to promote elimination and the application of static insulation with an electrode to the spine and the spark gap widely separated to promote nutrition without excitation prove beneficial. A non-fermenting nutritious diet, no meat nor eggs being allowed, with daily warm baths of five minutes' duration, to be substituted for a cold sponge if the patient does not react well are essential. Nutrition should be increased without increase of waste products. Mechanical vibration between the 2nd and 3rd dorsal vertebrae with the ball vibratode for five minutes or long enough to lower the blood pressure is beneficial. Outdoor life and in some cases a lim-

* Sajous. The Internal Secretions and the Principles of Medicine, page 1852.

ited amount of agreeable work may be desirable. The local manifestations disappear under the general selective treatment.

Epilepsy is a functional nervous disease, characterized by almost "abrupt loss of consciousness followed by tonic and clonic spasms ending in coma." The loss of consciousness may or may not be preceded by an "aura." The disease is either due to organic lesions of the brain associated with pressure or to functional derangements. In epilepsy there is an excess of toxic wastes and excessive vaso-constriction and often a rise of arterial tension.

These indications call for the removal of waste products by means of high colonic flushings with saline solution, and reduction and selection of food to limit the auto-intoxication. The quantity of food should be limited to the minimum necessary for the patient's physical requirements and should consist chiefly of milk, buttermilk, zoolak, koumiss, toasted bread with butter, fresh cream cheese, cooked cereals, cooked vegetables, except onions and cabbage, and cooked fruits. Uterine troubles should be treated as a rule with the static wave current per rectum for twenty minutes. Adenoids should be removed when present and gastric disturbances should be corrected. Other sources of irritation should be treated or removed as indicated. Mechanical vibration should be so applied as to lower the blood pressure—usually between the transverse processes of the 2nd and 3rd dorsal vertebrae. Daily baths and an open air life with quiet are beneficial. Mechanical vibration for the relief of constipation when present, is necessary.

Melancholia may be classified as (1) simple, (2) attonita associated with nutritional and circulatory disturbances, with stupidity, and (3) agitated. Melancholia may be associated with cerebral arterial anaemia. The cause should be discovered and removed or treated. Pelvic derangements when present should be relieved. Nutrition should be increased and general elimination promoted. Light baths, the static wave current and general spinal vibration of short duration with the ball vibratode for stimulation and a vibratory treatment of the liver, spleen and stomach with the disc vibratode as well as a mechanical vibratory treatment of the bowels are indicated. Nutritious, easily digested food, daily baths, exercise in the open air and cheerful environment should be included in the treatment. If necessary spinal vibration may be employed to increase arterial pressure.

Locomotor ataxia, a posterior spinal sclerosis, is characterized by "lightning pains, absence of knee jerk, Argyl-Robertson pupil, marked incoordination without loss of muscular power, diplopia, optic atrophy, impotency and unsteadiness on the feet when the eyes are closed." For the treatment apply long static sparks for the pain, friction sparks for anaesthesia, and the static wave current with a long spinal electrode for improving the nutrition of the cord. Dysthesia or anaesthesia should be treated with rapidly interrupted vibration with the disc vibratode over affected areas. The ordinary abdominal treatment with a disc vibratode, and rectal treatment should be employed for constipation. For the gastric symptoms vibrate the stomach with the disc

vibratode and with the ball vibratode vibrate the left 6th, 7th and 8th dorsal nerves near the spine. A mechanical vibratory treatment of the abdomen should follow as outlined in the following chapter. Treat conditions as they arise. Combine with the above vibratory treatment prolonged interrupted vibration with moderate pressure with the disc vibratode applied over the motor points of the affected muscles, particularly on the posterior aspect of the thigh or leg. This is especially beneficial over the motor points of the gastrocnemei holding the disc long enough to count twelve, six or seven times if the muscles do not relax. A deep interrupted vibratory treatment with the ball vibratode in the intervertebral spaces of the segment of the cord controlling the affected muscles may be given if necessary.

Graded exercises for muscle coordination are of great assistance to the static electrical treatment. It is best to begin with a step-up exercise. With the hands on the hips to help to preserve the body balance, feet in good position, have patient step up with one foot placing it on a foot stool, and then balance himself there while counting six; and then bring the foot to its initial position. This should be repeated three times, and should be followed by a like exercise with the other foot. When progress is noted, the feet should be alternated in stepping up. Care must be exercised not to over exercise, for the muscles become tired before the patient realizes it. Later other exercises should be gradually introduced, as, higher step-up exercises; standing on tip-toe; forward charging with one foot, both heels being on the floor, patient being in an upright position; forward charg-

ing with the knee of the extremity brought forward bent, the stationary leg being rigid, both heels being on the floor; line walking; side stepping; and exaggerated spring walking are also good as control improves. Practice walking with the toes slightly outward, placing the heel on the floor first, then rolling the feet uniformly from heel to toe so that every part touches the floor improves the normal walk. Sometimes the movement of making a turn has to be analyzed and the separate movements given to the patient as special exercises if he has difficulty in turning. During these exercises the patient is allowed to glance at his feet if he desires until he can do the exercise well. Thereafter he is to practice the exercise, looking directly forwards. These exercises generally cover a period of months. Usually the step-up exercise requires a week or two or more before the patient can be advanced to another exercise. The exaggerated spring walking exercise and walking with the feet in proper position and also rolling the foot uniformly from the heel to the toe are introduced as soon as possible, but the others are introduced only as the patient's proficiency warrants it. An exercise invaluable to facilitate rising from a chair, the patient being seated slightly forward on the chair but upright, is as follows. The patient being seated in a chair as aforesaid with his hands on his hips, places the right foot slightly in advance of the left with the toes pointing outward. The patient then with the body rigid inclines slightly forward at an angle and arises at the same time. He will soon accomplish this with the slightest effort.

Contracted pupils may be dilated and the diplopia be relieved to a remarkable extent by mechanical

vibration applied with the ball vibratode between the 2nd and 3rd and 3rd and 4th dorsal vertebrae for three minutes or so.

Radiant light and heat are also valuable adjuncts to be applied for improving nutrition when indicated, although as a rule tabetic patients do not tolerate light as a normal individual would. Sometimes hydrotherapy as a "cold brief douche to the spine and to relaxed muscles" is a useful adjunct after the patient begins to improve. Incontinence is treated as directed in the following chapter.

Paralysis agitans is a functional nervous disease, characterized "by muscular weakness, tremors, and rigidity." The cause of this trouble is not definitely understood. The motor symptoms point to the cortical motor centers. The sensory symptoms and the "local increase in temperature" as occasionally seen, Gowers believes point to involvement of the sympathetic system. In the writer's judgment constipation and the consequent auto-intoxication seem to be undermining factors. This condition calls for colonic flushings, and the institution of an easily digested diet, daily baths, radiant light and heat baths, and the administration of mechanical vibration to improve the general metabolism. The static wave current may sometimes be found beneficial. Nutrition should be promoted with the minimum of toxic wastes. Cyriax* also uses exercises and states that in most cases of paralysis agitans "frictions on the extensors on the back of the forearm entirely remove the tremors for a few seconds." He refers to nerve friction with the fingers. For exercises in the treatment of this trouble the reader is referred to

* Cyriax. The Elements of Kellgren's Manual Treatment, page 195.

the works of Cohen and Cyriax. "Charcot thought very highly of treatment by vibration in this disease and used for it the shaking chair, as well as local vibrations,—manual or mechanical. The feeling of constraint, due to the muscular rigidity is relieved by this application, and its use is thought to bring about favorable alterations in the peripheral nerve-endings, by both reflex and direct stimulation." Parathyroid extract given according to Berkley is beneficial in many cases.

Anterior poliomyelitis or infantile paralysis being probably due to an infectious process calls for increased elimination. The use of the 500 candle power lamp, the static wave current with mechanical vibration, and at first passive and later active exercise, is very beneficial in these most trying cases. The earlier these cases are treated the better the result. As the cervical or lumbar enlargement is the favorite site of structural changes in the cord, the static wave current is applied to the spine by means of a flat metal spinal electrode 1½ by 8 inches from above downward or from below upward or in young children the entire length of the spine according as conditions demand and a spark-gap of from ten to fourteen inches is employed for twenty minutes daily. Mechanical vibration is applied as follows. With the ball vibratode make interrupted applications alternately on each side of the spine between the transverse processes of the spinal vertebrae corresponding with the part of the cord affected directly and also in the region whose muscles are indirectly affected owing either to lack of power or restricted motion. The back should be vibrated in this manner two or three times. When the foot

is affected, make slightly prolonged interrupted application with the disc vibratode over the contracted muscles of the sole and about the ankle and the tibial part of the leg. Otherwise short interrupted vibration should be applied over the remaining portion of the foot and ankle. After having dusted the surface of the leg posteriorly with talcum powder, apply vibratory friction with the disc vibratode centripetally from the ankle to the knee covering the same surface each time three times in succession. The entire posterior surface of the leg should be vibrated three times. Interrupted vibrations are then applied to the knee joint posteriorly then vibratory friction centripetally is given over the thigh as for the leg. The same procedure is followed in vibrating the leg and thigh anteriorly. Interrupted vibration is also applied with the disc vibratode over the glutei. The same line of treatment is followed when an upper extremity is affected. For the hand, apply centripetal friction over the hand anteriorly and posteriorly three times over each single surface, this procedure being repeated three times over the entire hand. Interrupted vibration is then applied to the wrist making a resisting surface of the operator's other hand. Centripetal friction is then applied from the wrist to the elbow in the same manner, as when vibrating the hand, followed by interrupted vibration to the elbow-joint and centripetal friction from the elbow to the shoulder. Interrupted vibration is also applied to the axilla to promote the activity of the lymphatics, and over and around the shoulder joint and the weakened back muscles covering the era, about three times. Selected passive exercises are introduced as early as possible and the

child is encouraged to initiate movements of the affected parts. Daily active and passive exercises are very important. Later the mechanical vibration should be followed by exercises consisting of active movements slowly executed lying down, next like movements, sitting. Practice in standing erect with the feet placed in the correct position should follow, at first supported, later unhelped. Coordinate movements of the simplest form gradually increased in difficulty of execution should be done as soon as possible. The child should be encouraged to use or try to use the affected part in the *proper* manner. The prognosis as a rule is good, but both operator and patient must possess patience as the treatment should be continued for six months or a year. A properly adjusted support or brace not limiting natural movements but restricting unnatural movements is often beneficial.

Occupation neuroses are due to overuse of muscles and consequent nervous strain in (1) movements requiring co-ordination in the performance of skilled technique as in writing, when the flexors are most affected, piano playing, telegraphing, when the extensors are most affected, and similar occupations, (2) movements requiring work of more weight, as shoemaking and painting, characterized by chronic or tonic spasms of flexors or extensors, accompanied with marked fatigue, tremor, pain, and sensory disturbances. The condition is generally found in neurasthenic individuals, or those of neurasthenic tendencies. Wm. Benham Snow believes an accompanying neuritis to be characteristic of the trouble.

Mechanical vibration when employed with these patients, if there is no organic nervous condition

when properly applied acts as a tonic and sedative; promoting metabolism and improving nutrition. The indications are to remove the cause, rest the part, lessen the irritability and later to re-educate the muscles. Local treatment is always advisable, and many cases also require a constitutional treatment, spinal, static, or vibratory, as indicated to improve the general condition and raise the individual's resistance to normal. The accompanying neuritis calls for treatment as prescribed under *neuritis.*

The mechanical vibratory treatment is as follows: Employ centripetal vibratory friction with at first light and later moderate pressure, with medium stroke, employing the rubber-covered disc vibratode, beginning the application at the ends of the fingers, first on the dorsal side, moving the vibratode from the finger tips over the intermetacarpal spaces, six or seven times, to the wrist-joint. To the wrist it is best to make applications of deep interrupted vibration. Anteriorly apply vibratory friction from the finger tips to the wrist, traversing the surface six or seven times. Also apply deep interrupted vibration three or four times successively to the center of the palm to induce acceleration of the venous circulation. Then apply vibratory friction to the forearm, posteriorly and anteriorly as far as the elbow joint and about the elbow apply interrupted vibration as at the wrist. Continue the application of vibratory friction to the arm and apply interrupted vibration to the axillary region with the rubber-covered disc vibratode. Apply prolonged interrupted vibration also over the site of contraction. Stretching of the arm and shoulder joint is accomplished (1) by the operator and patient grasping each other's thumbs with the corresponding hands and

making a few vigorous elastic pulls, the applied force being gradual, but the withdrawal should be rather sudden, or (2) by the operator placing one hand on the shoulder and grasping the patient's hand and pulling carefully and steadily with the other hand. The patient should lie upon his back during such application with the arm raised upward.

After such treatment of the arm has been persisted in for a time, associated with rest from occupation, and when all spasms at least of the extensors have ceased, employ passive, and later active or resistive movements, as indicated. Use exercises singly or in unison of flexion, extension, and raising the fingers as in playing the piano, and of separating the fingers, gradually increasing in power and duration, two or three times daily. The exercises should be slowly executed. These exercises should be passive at first. When the parts are strong enough to initiate active movements, the patient should be encouraged to do so, care being taken not to overdo. Light work requiring no complicated finger movements should be gradually introduced before the writing exercises are prescribed. Wolff cured 157 cases of occupation neuroses, improved 22, and failed in 98 of 277 cases treated. He employed massage twice daily in combination with "exercises of bending and stretching, spreading and contracting of the hand and arms for hours until the hand was fatigued, and these were repeated until the patient was able to move each finger voluntarily in all directions. Elementary exercises in writing, prescribed and adapted to each case, also formed part of the treatment. Fixation of muscles by elastic bands, so as to give special exercises, was resorted to in some cases." These results were attested to by Billroth, Charcot, Esmarch,

and others. (Graham.) The successes were obtained in the cases which were characterized by tremor and spasm. The writer has pursued this plan of treatment associated with mechanical vibration instead of massage with marked success. Exercises were prescribed to be taken late in the evening and early in the morning, as well as at the time of treatment. Writing exercises must not be introduced too early. The pen should be held properly, the height of the stool and the desk, the position of the patient, and the manner of writing must be carefully regulated. Graham makes use of "resistive movements of supination of the forearm, of extension of the hand and of each finger separately." These he alternated with "massage every few minutes." Treatments twice daily are sometimes necessary.

HEMIPLEGIA is a paralysis of one-half of the body laterally and is classified with reference to the localization of the lesions and symptoms by Abrams* as follows:

Symptoms	*Seat of Lesion*
"Hemiplegia with motor aphasia.	3rd left frontal convolution.
Hemiplegia with paralysis of lower facial branches.	Posterior limb of internal capsule.
Hemiplegia with hemianæsthesia.	Posterior third of internal capsule.
Hemiplegia with crossed paralysis of third cranial nerve.	Crus cerebri on same side as paralyzed nerve.
Hemiplegia with crossed facial paralysis.	Pons paralyzed."

From a therapeutic point of view we are most interested in the causative conditions, which are: (1) *Embolism;* occurring principally in young people, in which case the onset of the paralysis is usually sudden, without loss of consciousness, and usually asso-

* Abrams. Clinical Diagnosis.

ciated with motor aphasia, and most often occurs in patients in whom a cardiac lesion is present. (2) *Apoplexy;* occurring usually after middle age, of sudden invasion "with loss of consciousness and usually associated with lower facial paralysis," and atheromatous arteries. White reports excellent results from the treatment of "a case of hemiplegia complicated with persistent insomnia." He applied the ball vibratode "in the interspaces between the transverse processes of the spinal column from the occiput to the last sacral vertebra" and a multiple point vibratode to the fingers and affected arm. Insomnia in this case was also relieved.. The writer has noted improvement following a vibratory frictional treatment of the arm in a case where the arm had been affected.

Apoplexy is preceded by an advanced arteriosclerosis with high arterial tension and is best treated by the institution of a regime including a diet of easily digested but nutritious food, devoid of meat and eggs;—high colonic flushings, or laxatives; the avoidances of excitement; a limited amount of well regulated exercise; and d'Arsonvalization or mechanical vibration to lower and control the blood pressure.

An application of interrupted vibration with the ball vibratode between the transverse processes of the 2nd and 3rd dorsal vertebrae for five minutes or ten if necessary, will generally lower blood pressure unless there is a cardiac insufficiency when vibration between the 7th cervical and 1st dorsal vertebrae is indicated. Local vibratory treatment as centripetal frictions with the disc vibratode over the muscles and interrupted vibration about the joints will prevent

muscular atrophy. Well directed limited exercises are beneficial. Cyriax* notes "that in some cases of hemiplegia, cervical nerve frictions will cause involuntary twitchings or even coarse movements to take place in the affected area, or leg."

Facial paralysis due to neuritis caused by cold is satisfactorily treated in many cases by applying the static wave current with a metal electrode, molded over the affected nerves and muscles, for twenty minutes daily followed each time by an application of the static brush-discharge. If the pupil on the affected side is contracted, it may be treated by applying mechanical vibration between the transverse processes of the 2nd and 3rd and the 3rd and 4th dorsal vertebrae for about five or ten minutes using the ball vibratode. One most interesting case noted an inability to read the lower line of the Snelling test card. Improvement promptly followed vibratory treatment applied as described.

Mechanical vibration is effective in the treatment of a few pathological conditions of the eye. "The vaso-constrictor neural cells† of the eye are from the 2nd, 3rd and 4th dorsal segments. The vaso-dilator neural cells of the eye are chiefly in the nucleus of the third cranial nerve, probably to some extent in the nuclei of the third and sixth. The visceromotor cells for the iris and ciliary muscles are as follows: Those which bring about a constriction of the pupil are in the nucleus of the third cranial nerve. Arnold thinks that the dilator cells for the pupil are found chiefly between the 6th cervical and 1st or 2nd dorsal segments." According to Landois

* Cyriax. The Elements of Kellgren's Manual Treatment, page 161.

† Arnold. Examination of the Back. *Medical News,* March 18, 1905.

the condition of the blood vessels affects the size of the pupil.* If they are injected, the pupil contracts, whereas diminution in the quantity of blood results in dilatation of the pupil, hence according to Arnold's findings for vaso-constrictor cells the dilator cells for the pupil would include the second, third and fourth dorsal segments. Since a segment refers to the site of the root origin of a nerve, the fourth dorsal segment refers to the origin of the fourth dorsal nerve whose exit is between the 4th and 5th dorsal vertebrae. In the writer's experience dilatation is best elicited between the 2nd and 3rd and the 3rd and 4th dorsal vertebrae. Landois† states that pupillary fibres for dilatation go as far as the second cervical nerve (in the rabbit) and anastomosing fibres pass from there "to the cilio spinal region and thence through the three or four thoracic nerves into the cervical sympathetic."

Dilatation of the pupil is induced by deep interrupted vibration in the intervertebral spaces from the 7th cervical vertebra to the 5th dorsal with moderate pressure. Stimulation of the fifth cranial nerve has the same effect. It is useful in the treatment of some forms of facial paralysis and for the eye conditions of locomotor ataxia.

Mechanical vibration when applied over the eye in the treatment of eye diseases should be employed in the form of a vibra-massage. Make the application for but a short time, 30 seconds to a minute or so, and as a rule only once daily, using a soft rubber cup vibratode with the shortest stroke and no pressure over the eye ball. In all cases indicated consti-

*Landois. Text-Book of Human Physiology, page 842.

† Landois. Text-Book of Human Physiology, page 749.

tutional treatment with due consideration of diet and hygiene must be observed. A study of the blood pressure should be made in every case.

Mechanical vibration of the eye is indicated for TWITCHING OF THE LIDS, BLEPHAROSPASM and GLAU-

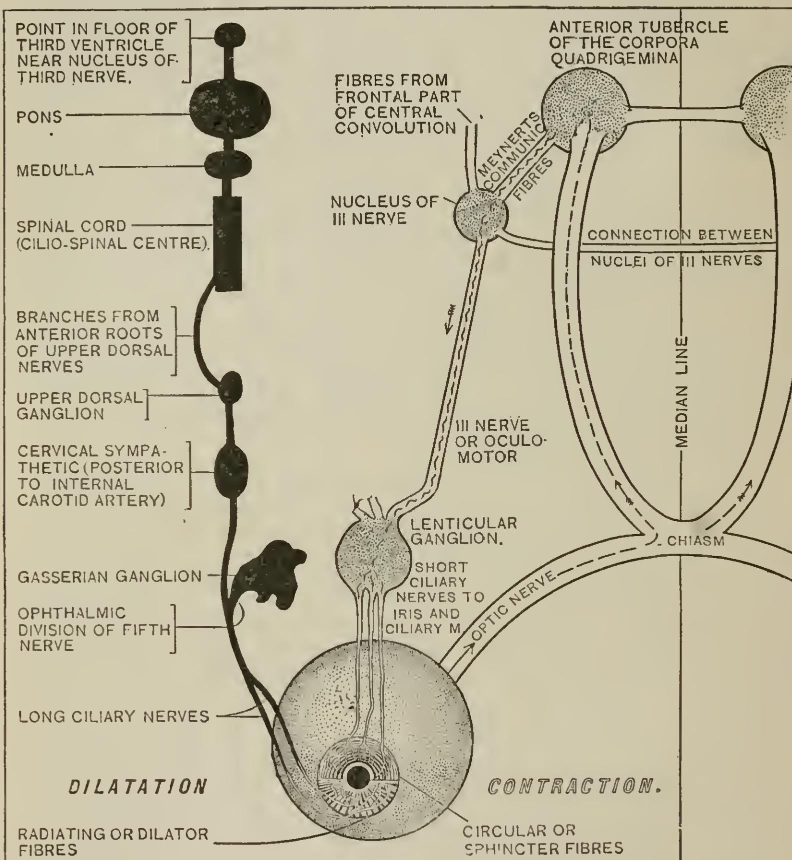

Fig. 53.—Nervous Mechanism of the Iris. Path of sensory stimulation through optic tract. Path of motor impulse through third nerve to sphincter fibres, causing contraction of pupil.

Solid black—path of impulses from point near nucleus of third nerve and cilio-spinal center through sympathetic to dilator fibres, causing dilatation of pupil. (Butler's Diagnostics of Internal Medicine. D. Appleton & Co.)

COMA. The *greatest gentleness and skill must be employed in the treatment of the eye, avoiding the possibility of causing irreparable injury, such as retinal detachment.* In some cases vibratory treatment alone is effective, while in others a combination with other methods gives the best results. As with other affections, treatments should vary from twice a day to once a week, according to the indications of the case.

Vibration like massage "is contraindicated in acute inflammation of the conjunctiva, cornea, sclera, iris, and ciliary body, and after accidents or purposive surgical wounds."

Mechanical vibration relieves muscular tension, assists elimination, and absorption, and stimulates the functions of the various structures of the eye.

In a case of GLAUCOMA, treatment consisted of light for ten minutes from a 50 candle power incandescent therapeutic lamp, static electricity for seven to ten minutes with a vacuum tube electrode, and vibramassage over the eyeball. d'Arsonvalization was given for the accompanying high tension with marked relief. These combined treatments were given three times weekly and with a most happy result. The vibration was given interruptedly each time over the closed lids, the cup-shaped vibratode being held in contact long enough to count ten rapidly. About ten applications were thus made at each treatment. It gave a feeling of comfort after the administration of the light and the static current, and assisted in relieving the tension. The administration must be made with the *greatest* gentleness and for but a few seconds.

Retinal anaemia was successfully treated by the late Dr. Maurice F. Pilgrim by the application of mechanical vibration "over the vaso-motor area in the spinal cord, which influences the blood supply of the eye—at the junction of the fourth and fifth dorsal. It was also applied to the third and fourth cervical, and over the sub-occipitals, for its derivative effect through relaxation of muscular contractures." Vibration was not applied over the eyeball for more than six times and then but "for a few seconds." Treatment was administered daily.

The muscles of the eye are supplied by the 3rd cranial, the motor oculi, which also supplies the levator palpebrae superioris, rectus superior, inferior and internal, and the obliquus oculi inferior. The 4th nerve supplies the obliquus oculi superior, and the 6th the external rectus. These nerves are best affected by vibrating through their connection with a division of the superior cervical ganglion.

In paralysis of the muscles of the eye vibra-massage combined with an exercise as stretching and contraction of the affected muscles may be employed.

Secretion of tears may be reflexly induced by stimulating the mucous membrane of the nose or by direct stimulation of the cervical sympathetic.

Auditory nerves are excited by mechanical vibration "of the end-organs of the acoustic nerve due to the wave-motion of the lymph of the labyrinth." The nerves of the auditory canal come from the auricular branch of the pneumogastric and the inferior maxillary of the fifth and these with a branch of the glosso-pharyngeal supply the membrani-tympani. The muscles of the ear are supplied by the facial nerve.

The nerves of the middle ear constitute the branches of the otic ganglion. They comprise a branch of the facial chorda tympani nerve, a branch of the glosso-pharyngeal, one from the carotid plexus of the sympathetic and a branch of the great superficial petrosal. Those of the Eustachian tube are derived from branches of the sympathetic through the pharyngeal plexus, which comprise also a branch from the superior cervical ganglion, some nasal branches from Meckel's ganglion, and some branches from the pneumogastric and glosso-pharyngeal. The blood vessels of the ear are derived directly or indirectly from the external and internal carotid. The vaso-constrictor neural cells for the ear are found in the 2nd, 3rd and 4th dorsal segments (Arnold).* The vaso-dilator† nerves of the blood vessels of the ear are from the inferior cervical ganglion and the first dorsal.

THE EXTERNAL EAR is supplied by the auricularis magnus, which is made up of a branch of the 2nd and 3rd cervical nerve, a branch from the facial, pneumogastric, inferior maxillary, occipitalis minor, one from the 2nd cervical nerve, and another branch from the posterior division of the 2nd cervical nerve.

When the tragus is vibrated interruptedly the shortest stroke should be employed and a moderate rate of speed, with a cup vibratode. Apply the vibration in such a manner as to open and close the external meatus. In treating the ear locally always make use of a soft rubber vibratode.

The above method is employed for the purpose of exercising the structures of the middle ear, and should be followed by treatment directed to the

* Examinations of the Back. *Medical News,* March 18, 1905.

† Landois and Stirling.

Eustachian tube. This is best accomplished by applying vibratory friction with light pressure to the neck in the groove behind the ear following downward in the space between the angle of the jaw and the mastoid process along the anterior border of the sterno-cleido-mastoid muscle in its upper part. The latter treatment is instrumental in relieving *inflammation and obstruction of the Eustachian tube, and also itching of the throat* caused by obstruction of the tube. For exercising the tympanum a pneumomassage apparatus has been found useful.

Chronic diseases of the middle ear when suppuration is not present may be treated by mechanical vibration. In catarrh of the tube it may be employed, and it is sometimes of value for relief of tinnitus aurium. Tinnitus aurium may be due to either central or peripheral lesions. Abrams classified them as follows: "To the former (central) belong those noises produced exclusively by pathological changes of the structures of the labyrinth; and peripheral, to those due to causes external to the labyrinthal structures. Noises originating in the labyrinth may be caused by exudation, increased pressure, anaemic and hyperaemic conditions, and from the action of drugs. These noises are always associated with a disturbance of hearing. Catarrh of the middle ear frequently gives rise to entotic or subjective noises. Sometimes the noises come from the vessels, particularly the carotid, which passes in close proximity to the ear. Other noises emanate from the jugular fossa, and others are produced by muscular contraction, particularly of the masseter" muscles. If an acute inflammation exists only the parts around the ear should be treated by vibration,

PLATE XI.—Application of Pneumo-Massage to the Ear.

not the ear itself. In ear troubles as in other conditions, the removal of causes, and the building up of tissue resistance is indicated.

Compressing interrupted vibration or the X-ray is indicated in cases of AURICULAR INDURATION after healing of the incision after operative procedures.

Success in the treatment of CATARRHAL DEAFNESS has been reported by Bellows, who used rapid vibration, "in and out movement, 15 seconds at a time followed by the high frequency current for two minutes at each treatment." He sometimes substituted the Faradic for the high frequency.

Vibration may be used more particularly in combination with exercise, static electricity, or some other measure to assist in obtaining the greatest degree of success in the treatment of many of the preceding conditions.

CHAPTER XII

Relation of Mechanical Vibration to the Digestive System

The functions of digestion and assimilation are associated with physical (mechanical) and chemical processes, which under atonic or otherwise impaired conditions may be restored by the judicious employment of mechanical vibration, alone or in combination with indicated auxiliary measures.

Mechanical vibration is therefore a valuable means for inducing the functional activity and correcting other derangements of digestion. The applications require skillful regulations as to site and adaptations of speed, stroke, pressure, and time to the conditions present and to the patient's natural resistance.

Constitutional vibratory treatment, i.e., the spinal treatment, when not prolonged, will produce a general sedative effect associated with a sense of buoyancy.

The salivary glands get their nerve supply from the sympathetic and from a cranial nerve.

"1. The sympathetic nerve* gives branches (a) to the submaxillary and the sub-lingual glands derived from the plexus on the external maxillary artery; (b) to the parotid gland from the carotid plexus. These nerve fibres can be traced to the superior cervical ganglion and from thence through the cervical sympathetic into the cord."

"2. The facial nerve gives branches to the sub-

* Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 251.

maxillary and sub-lingual glands from the chorda tympani which accompanies the lingual branch of the fifth nerve." The branches of the parotid arise from the tympanic branch of the glossopharyngeal nerve (dog). "The tympanic plexus joins the otic ganglion, and this ganglion sends branches to the auriculo-temporal nerve (itself derived from the third branch of the trigeminus), which as it passes upwards to the temporal region under cover of the parotid, gives branches to this gland."

"The sub-maxillary ganglion, which gives off branches to the sub-maxillary and sub-lingual glands, receives fibres from the tympanico-lingual nerve (chorda-tympani) as well as sympathetic fibres from the plexus on the external maxillary artery."

Sajous* states that over the blood vessels of the sub-maxillary gland (of a dog) are "entwined sympathetic fibres from the superior cervical ganglion which fibres are inclosed in a common sheath with the main sensory nerve present, the vagus," which strengthens the belief that they "must in a measure govern the quantity of blood distributed to the organ." His deductions in regard to the functional mechanism of the sub-maxillary are as follows:

"Some fibres of the chorda tympani are distributed to the secreting elements to excite and govern their metabolism; the remaining fibres of the same nerve are distributed to some of the glandular arterioles, but not to those which supply capillaries to the secreting elements. While the gland is in the passive state the blood flows equally through all arterioles.

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* Sajous. The Internal Secretions and the Principles of Medicine, pages 272 and 275.

"When the gland is active, the chorda tympani constricts the arterioles to which it supplies fibres, and thus forces the bulk of the blood through the free arterioles and thence into the glandular capillaries.

"The rapidity of the blood-flow through the organ is concurrently increased through sympathetic constriction of the extra-glandular arterial branches functionally connected with the gland."

Arnold* believed that the vaso-constrictor neural cells for the salivary glands are in the 2nd, 3rd and 4th dorsal segments and the vaso-dilator neural cells of the sub-maxillary and sublingual glands are in the nuclei of the 7th cranial and of the parotid glands in the nucleus of the 9th cranial.

If the sympathetic nerve which contains vaso-constrictor as well as secretory fibres be stimulated it causes a thick secretion in the sub-maxillary abounding in mucin, thereby increasing the normal specific gravity of the secretion. Contraction of the blood vessels and lessening of the rapidity of the venous circulation also result. It is probable that "the nerves exercise a direct effect upon the secretory cells, apart from their action on the blood vessels." Ludwig demonstrated that while secretion is active the rise in the temperature of the glands is 1.5° C., and according to Landois and Stirling,† whether the stimulus be electric or other stimulus "of the peripheral end of a glandular nerve the following changes occur:

"(1) Vaso-motor changes, causing alterations in the blood supply and blood-flow.

* Arnold. Effects of Vibration on the Back. *Medical News,* March 18, 1905.

† Landois and Stirling. Text-Book of Human Physiology, 4th edition, page 255.

"(2) Chemical and histological changes in the gland-cells connected with the elaboration of the organic and possibly of the inorganic constituents of the saliva.

"(3) Changes by which water is secreted, i.e., passes through the basement membrane and gland-cells and the consequent movement of the fluid through the cells and ducts.

"(4) Electrical changes which do not seem to be associated with the vaso-motor changes, for the electrical variations are readily abolished by atropin which does not affect the vaso-motor changes."

Stimulation of remote sensory nerves, as the sciatic, affects the parotid gland reflexly, causing secretion of the saliva (Owsjannikow and Tschierjew). When considering the effect of vibratory stimulation upon the glands it is well to mention the results of one of Colombo's experiments. He found that "the parotid gland did not respond so quickly as the salivary. Increased secretion occurred after 5 minutes' massage but 10 minutes were required for the maximum secretion." Less time is required for the induction of a corresponding effect with mechanical vibration.

Cyriax* reports cure in a case of EPIDEMIC PAROTITIS, the treatment being as follows: "Vibrations (manual) and shakings, followed by frictions on the salivary glands and on the swollen lymphatic glands; running vibrations from above downwards along the sterno-mastoids; frictions on the facial nerves and on the nerves lying in the sub-maxillary region. General treatment for fever."

Mechanical vibration applied to the glands should

* Cyriax. Elements of Kellgren's Manual Treatment, page 290.

be administered with the rubber-covered disc or cup-shaped vibratode and may be applied by friction or interruptedly. Vibration of the PAROTID GLAND, which "lies upon the side of the face immediately below and in front of the external ear" should be begun behind the ascending ramus of the jaw and continued downward. In front of the external ear vibrate forward. Then follow the line of Steno's duct—"a finger's breadth below the zygoma from the lower part of the concha to midway between the free margin of the upper lip and the ala of the nose." The vibration should be applied lightly with a medium stroke.

Vibration of the SUB-MAXILLARY GLAND should begin halfway between the angle of the jaw and the mentum as it is below and to the inner side of the lower jaw. Vibrate up and forward in the direction of Wharton's duct with interrupted vibratory applications.

The SUB-LINGUAL GLAND can be reached behind the chin. Vibrate upward and forward.

THE PHARYNX, extending from the "under surface of the skull to the cricoid cartilage in front and the intervertebral disc between the 5th and 6th cervical vertebrae behind," receives its nerve supply from the pharyngeal branch of the pneumogastric. This branch, which is "the principal motor nerve of the pharynx, arises from the inferior ganglion of the pneumogastric, receiving a filament from the accessory portion of the spinal accessory, passes across the internal carotid artery to the upper border of the middle constrictor." Here it divides into filaments communicating with those from the external branch of the superior laryngeal, the glosso-pharyn-

geal and sympathetic to make the pharyngeal plexus which supplies the pharyngeal muscles and mucous membrane.

The glosso-pharyngeal nerve supplies "fibres of ordinary sensation to the pharynx and is the motor supply of the stylopharyngeus and the superior and middle constrictor. It is found "below and internal to the horizontal ramus of the jaw."

When applying mechanical vibration to the pharynx use the small cup-shaped vibratode, beginning posterior to the ascending rami and administer vibratory interruption or friction from above downward.

In chronic follicular pharyngitis mechanical vibration has already been demonstrated of value. Morse treated a case successfully by vibrating "deeply over the cervical spinal nerves, and externally over the glands of the neck," presumably to control the vaso-motor area of the head to lessen congestion, and to unload the lymphatics, particularly the cervical glands. To this treatment may be added vibratory friction of the neck anteriorly and posteriorly.

Mechanical vibration promotes to a marked degree the functional activity of the liver, stomach, and intestines—both promoting absorption and increasing peristaltic activity.

Hepatic activity may be induced (1) directly by applying over the liver interrupted vibration with moderate or deep pressure and medium stroke followed by vibratory friction; (2) indirectly or reflexly by the application of abdominal vibration or spinal stimulation.

Professor Colombo of Turin demonstrated in re-

spect to biliary secretion that, "after ten minutes of trepidation (shaking or vibration) and of tapotement or percussion the quantity of bile increased considerably in the next four hours. The cholestrin and the biliary soda salts were most abundant. After twenty-five minutes of friction and of petrissage the same results were obtained as after ten minutes of trepidation and tapotement; the maximum result was obtained by combining ten minutes of friction and petrissage." These observations are of great interest and importance in vibration therapy; because they well illustrate the relative effects of various modes of application in respect to time. Vibratory stimulation by increasing biliary excretion assists in staying putrefaction, aids in the emulsification of fats, increases intestinal secretion and peristalsis, and supplies a natural purgative and intestinal antiseptic.

The nervous supply of the liver* consists "first, of terminal subdivisions of the general motor system (splanchnic-sympathetic), which furnish nervous energy during the passive stage of functional activity by insuring tonic contraction of all vessels, and, second, of terminal subdivisions of the vagus, which excite and govern the active stage of functional activity by regulating the calibre of the hepatic arterioles and by supplying nervous energy to the hepatic cells." Arnold† stated that the vaso-constrictor neural cells of the liver are "from the 6th dorsal to the 1st lumbar segment, but chiefly in the 10th, 11th and 12th dorsal segments and that the

* Sajous. The Internal Secretions and the Principles of Medicine, page 360.

† Arnold. Examination of the Back, *Medical World*, March 18, 1895.

vaso-dilator neural cells are in the nucleus of the 10th cranial nerve."

The effects* of nerve stimulation on biliary secretion are as follows: *"All conditions which cause contraction of the abdominal blood vessels,* e.g., stimulation of the ansa Vieussenii, of the inferior cervical ganglion, of the hepatic nerves, of the splanchnics, of the spinal cord (either directly by strychnia, or reflexly through stimulation of sensory nerves), affect the secretion. *Stimulation of the nerves around the hepatic artery* causes at first, an *acceleration,* and afterwards *slowing* of the *secretion."* A rapid and copious blood supply favors secretion The velocity influences it more than blood pressure. A more copious supply of blood to other organs, e.g., to the muscles of the trunk—during vigorous exercise, diminishes the secretion. "Stimulation of the spinal cord, from which the motor nerves of the larger bile ducts and gall-bladder pass, causes *acceleration of the out-flow,* which is afterwards followed by a diminished out-flow. *Direct stimulation of the liver,* and reflex stimulation of the spinal cord, diminishes the excretion. By stimulation of the sympathetic at the lowest cervical and first thoracic ganglion, the hepatic vessels at the periphery of the liver lobules become contracted and pale. (Cyon.)"†

"Francois-Franck and Hallion‡ have shown that the vaso-motor nerves of the liver leave the spinal cord by the rami below the fifth, i.e., the sixth

* Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 338.

† Landois and Stirling. Text-Book of Human Physiology, 4th edition, pages 330 and 340.

‡ Sajous. The Internal Secretions and the Principles of Medicine, page 1012.

(dorsal) down to the second lumbar. These limits have been confirmed by Langley. The former physiologists remark however that 'centrifugal excitation of the vertebral nerve (composed of 4 or 5 of the lower cervical nerves) after section of the upper rami communicantes (from the first to the fifth) *no longer* produces hepatic vaso-constriction '—a statement which implies that stimulation of the vertebral nerve *does* produce hepatic vaso-constriction. The manner in which this effect is brought about, Francois-Franck and Hallion were unable to explain, however, they ascribed them, therefore, to 'reflex action' or to some unexplained 'indirect influence.' " This influence according to Sajous is due to overactivity of the adrenals.

Landois* states that "stimulation of its (the splanchnic nerve) central extremity causes relaxation of ducts and bladder, while stimulation of the central end of the pneumogastric causes their contraction, together with relaxation of the sphincter of the duodenal orifice."

Mechanical vibratory treatment for relieving TORPIDITY OF THE LIVER is applied as follows. With the patient lying in a prone position, apply interrupted vibration with moderate pressure and medium stroke with a ball vibratode to the dorsal region of the spine, and note the points of tenderness. Then apply vibratory friction over the liver posteriorly with the disc vibratode moving from the spine outwards over the spaces between the ribs. After a rest of a few minutes, with the patient in the first position, he should then lie upon his back and interrupted vibration should then be applied with moderate pressure

* Landois. Text-Book of Human Physiology, page 321.

and medium stroke over the liver anteriorly, employing medium speed and a stroke suited to conditions of each case. "One of the causes of the excretion of bile is the *interrupted periodic compression* of the liver from above by the diaphragm at every inspiration."

The observation has been made by the writer that in many cases of morbid states of the liver, tender-

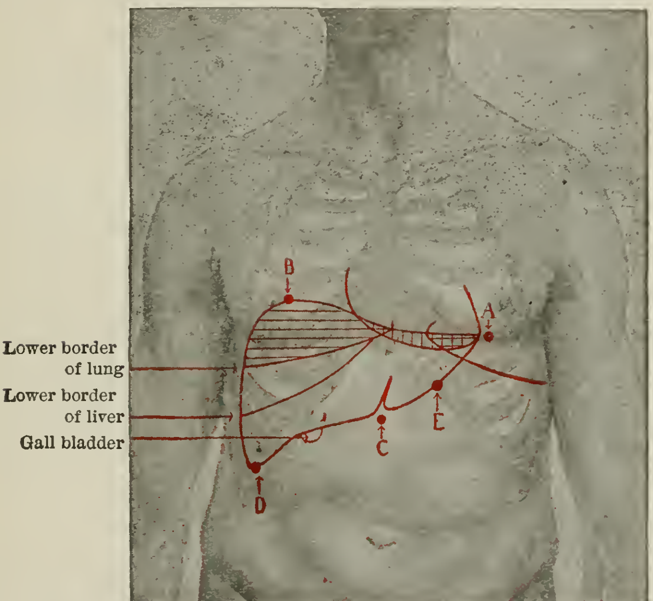

Fig. 54.—Showing the points which determine the size and position of the normal liver. Horizontal shading-portion of liver overlapped by lung, vertical shading-portion of liver overlapped by heart. (Butler's "Diagnostics of Internal Medicine," D. Appleton & Co.)

ness is elicited by interrupted vibration with the disc vibratode below and internal to the inferior angle of the right scapula. These areas of tenderness correspond to the 6th and 7th dorsal nerves which may be vibrated at their vertebral exits between the 6th and 7th and 7th and 8th dorsal vertebrae with the ball vibratode.

Percussion of the liver elicits* according to Butler:

Limits of covered dulness	Upper—4th space in mammillary line.
	7th space in midaxillary line.
	9th space in scapular line.
Limits of exposed dulness	Upper—6th rib in mammillary line.
	8th rib in midaxillary line.
	10th rib in scapular line.
Limits of exposed dulness	Lower—3½ to 4 in. below ensiform appendix in anterior median line.
	Costal margin in mammillary line.
	10th space in midaxillary line.
	Fuses with dulness of right kidney in scapular line.

The liver reflex of contraction (Abrams) is obtained by vibrating with the ball vibratode for five or ten minutes with short rest intervals between the 1st and 2nd, and the 2nd and 3rd lumbar vertebrae. This procedure is indicated in hepatic engorgement unless contraindicated by the nature of the cause of such engorgement as in abscess or cancer of the liver. In combination with high colonic flushings it relieves the symptoms of such engorgement.

The liver reflex of dilatation (Abrams) is elicited by prolonged spinal vibration with few interruptions for five or ten minutes between the 11th and 12th dorsal vertebrae. It must be remembered that mild applications stimulate but strong or long continued exhaust or inhibit an action; therefore in vibratory administrations proper discrimination must be observed.

Vibratory treatment of the liver is *contraindicated* in cancer of the liver, in acute attacks of hepatic

* Butler. Diagnostics of Internal Medicine, page 464.

colic, in cases of acute gastro-duodenitis, and in hepatic abscess.

Mechanical vibratory treatment applied with upward stroking to the extremities will temporarily relieve oedematous conditions due to interference with circulation as in CIRRHOSIS OF THE LIVER and NEPHRITIS. The writer employs for this purpose a rubber-covered disc vibratode with interrupted vibration over the inguinal glands followed by vibratory friction centripetally from the knee to the groin. Dusting the surface with a dusting powder greatly facilitates the administration of the friction. To the knee-joint apply deep interrupted vibration with deep pressure and medium stroke, after which apply vibratory friction from the ankle to the knee, followed by deep interrupted vibration to the foot and interrupted vibration on the sole of the foot under the instep. When giving the above treatment, the posterior as well as the anterior surface of the limb is treated. Properly applied joint movements may be used with advantage to assist the process.

FOR THE APPLICATION OF MECHANICAL VIBRATION TO THE GALL-BLADDER employ deep interruptions at about the 9th costal cartilage outside the edge of the right rectus muscle, downwards and inwards toward the median line. Follow the line described four or five times across. The vibratode best suited for the purpose is the flat disc, which should be crowded up to where the lower edge of the liver can be located. During the administration the abdominal muscles should be relaxed. The gall-bladder and the ureters "are the parts least excited by stimuli." If interrupted vibration is applied with pressure with a disc vibratode relaxation is induced.

When gall stones are present, however, vibration is sometimes contraindicated and in any case if applied the greatest care must be observed. In order to *break up biliary calculi* which have become impacted, Professor Bartholow recommended "that firm friction be made with the fingers along the inferior margin of the ribs toward the epigastrium and umbilicus while the opposite side posteriorly is supported by the other hand spread out and firmly ap-

Fig. 55.—Topographical relations of the stomach. (After Butler.)

plied." Vibration may be so applied, but the author favors the use of light, olive oil, and diet, succinate of soda or surgical measures.

The cardiac end of the stomach is situated "just below the level of the junction of the 7th costal cartilage with the sternum," and the pylorus is "near the end of the cartilage of the 8th rib." Any stimulation affecting stomach secretion affects proteid digestion. The peristaltic action of the stomach is affected by direct stimulation as massage or mechanical vibration.

When percussing the stomach it should be re-

membered that the thorax and liver overlap above, and the transverse colon is in close proximity below. "The normal stomach tympany begins at the site of the apex of the heart about at the 4th intercostal space in the axillary region, extending below this into the abdomen so that its greater curvature ex-

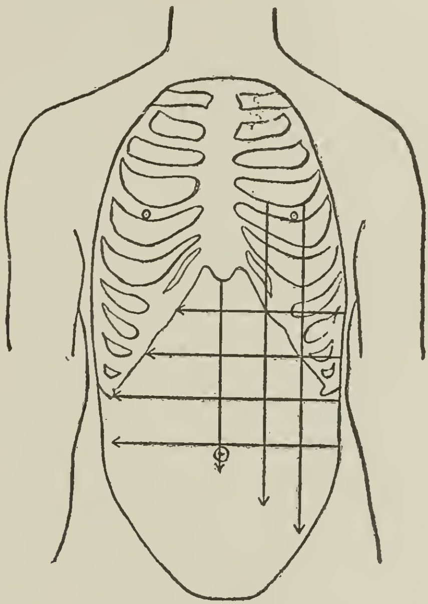

Fig. 56.—Showing the routes of systematic percussion of the stomach for the purpose of mapping out its size, position and the location of growths. (Bassler's "Diseases of the Stomach and upper Alimentary Tract," F. A. Davis Co.)

tends from about the 9th costal cartilage, across the abdomen above the umbilicus to the right of the median line."

Gastric secretion may be induced by stimulation,—mechanical, chemical, or thermal. Landois and Stirling consider the function to be a reflex one, the special center for which is probably located in Meissner's plexus. The same eminent authorities

acknowledge that there are indications also that a connection exists "perhaps indirect between the central nervous system and the gastric glands." It was said by Pilgrim that stimulation of the glands can be produced by stimulating the vagi in the neck, but on this point authorities differ. Landois and Stirling state that "there is no nerve passing to the stomach whose stimulation causes a secretion of gastric juice as the chorda tympani does in the sub-maxillary glands," but Pawlow "found that direct stimulation of the vagus produced a flow of gastric juice."

Colombo demonstrated that after massage the quantity of fluid exuded from a "gastric fistula for two hours was more than double that which flowed through in the same time without massage. A massage (manual) of fifteen minutes gave the maximum secretion. If massage was applied for a longer time the mucus increased, the gastric juice was more diluted. Hydrochloric acid and pepsin did not increase." The author had skiagraphs taken before and after vibration following a bismuth dose. Vibration was given between the 1st and 2nd and 2nd and 3rd lumbar vertebrae for 10 minutes. The skiagraph showed a 50 per cent increase in motility.

Experiments have also been made demonstrating the effects of manual massage upon the stomach with salol which is not soluble in the stomach. Ewald and Eccles experimented and found, according to Graham, that "in most cases under natural conditions without massage, salol could be detected in the urine in forty-five minutes after its administration; but after massage upon the abdomen for fifteen minutes the reaction of salol was obtained in thirty minutes," and according to the same authority, Hopädze

"showed that abdominal massage hastened the food from the stomach from fifteen to seventy-five minutes."

The general motor (sympathetic) and the vagus systems supply the stomach. Sajous believes:*

"1. That the general motor system (sympathetic) supplies efferent nerves which maintain tonic arterial contraction and control functional efficiency" during the *passive* state, while the vagus system (supplying sensory and motor nerves) is superadded during the *active* state and "assumes control of the digestive process."

"2. The extrinsic efferent nerves from both systems, constitute its extrinsic vaso-constrictor system, by means of which the flow of blood in the organ is increased."

3. The intrinsic efferent nerves are formed of (1) the branches of the "general motor system" (sympathetic system) each of which divides into two branches, one going to the arterioles, and the other supplying the muscles and glands, and (2) of branches of the vagus "which inosculate with the general motor filaments and plexuses, except with those distributed to arterioles that supply capillaries to the glands and probably end in the muscularis mucosae.

Arnold thought that the vaso-constrictor neural cells of the stomach were in the 4th to the 9th dorsal segments and the vaso-dilator neural cells of the stomach were in the nucleus of the 10th cranial nerve.

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* Sajous. The Internal Secretions and the Principles of Medicine, page 309.

Landois and Stirling* regard Auerbach's plexus as its motor center, the vagi conducting the impulses. "*Stimulation of the vagi in the neck causes contraction of the pylorus* (and upward from the pyloric end) when the latent period may be seven seconds. *Stimulation of the splanchnics* in the thorax *arrests* the spontaneous pyloric contractions, the left splanchnic being more active than the right (Oser)." Other fibres "pass from the spinal cord in the anterior roots of the nerves from the sixth to the twelfth dorsal, passing in the splanchnic nerves to the solar plexus, and thence to the stomach." If the splanchnics be stimulated, the muscular movements of the stomach cease, and the *sphincter of the pylorus relaxes* (Kirke). Pilgrim claimed that stimulation of the fourth dorsal would open the pylorus. The *cardia may be opened reflexly by stimulation of the sensory abdominal nerves* (e.g., of the kidney, uterus, intestine), or irritation of the sciatic. Landois and Stirling locate the center for the contraction of the body of the stomach in the corpora quadrigemina. "The efferent paths lie in the vagi, but chiefly in the cord, and from the latter emerge to the ganglia of the sympathetic. Inhibitory centers lie in the upper part of the cord, and the efferent paths are in the sympathetics and splanchnics." "Mechanical stimulation causes contraction of the muscular layers directly affected."† The visceromotor accelerating cells for the stomach according to Arnold are principally in the tenth cranial nerve, possibly also in the eleventh and the inhibitory visceromotor cells are chiefly in the fourth to the ninth dorsal segments.

* Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 281.

† Landois. Text-Book of Human Physiology, page 281.

Mechanical vibration applied to the stomach improves the general tone, and increases motor and glandular activity, thereby aiding nutrition.

Mechanical vibratory treatment of the stomach should never be administered directly after eating, and the bowels should be as nearly evacuated as possible, and the bladder emptied. Vibration should not be applied over the abdomen with so much force as to cause pain. If the patient be ticklish avoid too light vibration. If the abdomen be sticky from perspiration dust it with talcum powder before vibrating. Vibration may be followed by visceral lifting, if advisable, for the purpose of restoring the viscera to their normal positions.

Visceral lifting, a plan followed by Kellogg, is accomplished as follows: The operator, standing at the left side of the patient, his back being toward the face of the patient, places "the ulnar edge of the two hands, with the fingers extended, just above Poupart's ligaments and parallel with the ligaments, the fingers pointing toward the pubes. From this position the hands are moved slightly upward, the edge of the hands being made to sink as deeply into the abdomen as possible without severe pain. The arms being slightly rotated at the same time, and the hands drawn upward in such a way as to grasp the contents of the abdomen and drag them upward." This should be done during inspiration. At the same time use inspiratory lifting, that is, the patient having expired the air from the lungs should "make the movement of inspiration by lifting the upper chest forcibly while keeping the glottis closed."

With the flat rubber-covered disc vibratode vibrate from the cardiac end of the stomach using inter-

rupted vibration or vibratory friction proceeding downward and slightly inward. Then vibrate over the pyloric end of the stomach upwards and slightly outward. This area should be gone over about three times, pressure being regulated according to the patient's tolerance. In pathological conditions of the stomach, vibration of the 6th, 7th and 8th dorsal nerves on the left side will usually elicit tenderness, and eructations often occur. An application of static sparks over these sites also causes eructations. When the pylorus is affected, the same nerves on the right side are tender. The 6th, 7th and 8th dorsal nerves should be vibrated at their origins or exits employing the ball vibratode, and moderate speed in order to produce these effects. The tenderness is treated by prolonged interrupted vibration.

REFLEX DILATATION OF THE STOMACH (Abrams) is effected by concussion or vibration of the spinous process of the 11th dorsal vertebra.

REFLEX CONTRACTION OF THE STOMACH (Abrams), is produced by vibration by applying the ball vibratode between the transverse processes of the 1st and 2nd, and the 2nd and 3rd lumbar vertebrae for five or ten minutes as effects may demand with a rest period of a few minutes after the first five minutes' treatment. This can be used to empty the stomach.

VOMITING is a reflex act induced by afferent and efferent stimuli "occurring in consequence of contraction of the walls of the stomach, the pyloric sphincter being at the same time closed." The center "is connected with the respiratory center,* hence any agent increasing respiratory movements has a favorable effect upon vomiting." The "afferent im-

* Landois. Text-Book of Human Physiology, 4th ed., page 282.

pulses may be discharged from (1) the mucous membrane of the soft palate, pharynx, root of the tongue (glosso-pharyngeal nerve) as in tickling the fauces with the finger, (2) the nerves of the stomach (vagus and sympathetic), (3) stimulation of the uterine nerves (pregnancy), (4) the mesenteric nerve (inflammation of the abdomen and hernia), (5) nerves of the urinary apparatus (passing a renal calculus), (6) nerves to the liver and gall duct (vagus), (7) nerves to the lungs in phthisis (vagus)."

The efferent impulses are carried by the phrenics (diaphragm), vagus (oesophagus and stomach), and intercostal nerves (abdominal muscles)."* Dr. W. E. Green of Arkansas reports the cure of a case of persistent vomiting following two operations for its cure. The ball vibratode was used on alternate days for deep interrupted vibration "in the interspaces over the transverse processes of the third and fourth dorsal nerves, and throughout the splanchnic region." He probably induced dilatation. There was present at first a pyloric stricture. In spasmodic stricture of the pylorus, vibration of the fourth or fifth dorsal is indicated.

THE PANCREAS is situated behind "the linea alba, about two or three inches above the umbilicus," half way between the ensiform appendix and the navel and corresponds to the 2nd lumbar vertebra. Its head is in the duodenal curve and its tail reaches the spleen.

Sajous† believes that:

"1. When the pancreas is in the resting state, the general motor mechanism (sympathetic) maintains

* Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 282.

† Sajous. The Internal Secretions and the Principles of Medicine, page 385.

the tonic contraction of the vascular supply and alone transmits impulses to all the structures of the organ, including the glands which, during this period, elaborate their secretory products.

"2. When as a result of physical (reflex) or psychical stimuli the pancreas becomes functionally active, the vagus impulses impose their rhythm upon the general motor nerves, and the vagus system assumes control of the secretory process."

The nerves which supply it are from the "hepatic, splenic and superior mesenteric plexuses to which the pneumogastric and splanchnic nerves send branches." If the "central end of the vagus or certain sensory nerves, as the crural or sciatic, be stimulated suppression of the normal (pancreatic) secretion results." It has been claimed that the vaso-constrictors of the pancreas are from the fifth dorsal to the second lumbar. The vaso-dilators are said to be mostly in the vagus. Arnold states that the vaso-constrictor neural cells are in the 8th to 12th dorsal segments with some above the 8th, and the vaso-dilator neural cells are in the nucleus of the 10th cranial nerve. The blood vessels are dilated during the act of secretion.* Direct stimulation of the gland itself by induction shocks stimulates or excites secretion. Mechanical vibration applied directly over the gland should produce practically the same result. A rubber-covered disc vibratode should be used to apply interrupted vibration or vibratory friction when treating the gland itself. In vibrating the gland, begin at the splenic end, and if vibratory frictions are used, apply friction from the splenic end toward the patient's right side when the direc-

* Landois. Text-Book of Human Physiology, page 307.

tion should be to the right and slightly downward and outward following the line of the pancreatic duct.

Constipation is characterized by "an abnormal sluggishness and imperfect evacuation in the movement of the intestinal contents through their canal," which may be due to (1) atonic conditions caused by insufficient blood supply in debilitated states, as relaxed abdominal walls, atony of the intestinal tract; (2) obstructive causes as an interference mechanically with fecal expulsion as fibroid tumors, hypertrophy of Houston's valves, of the sphincter, or of the levator ani muscles, accumulation of feces, uterine and vaginal displacements; (3) habit; (4) various diseases of the spinal cord as tabes, hemiplegia and transverse myelitis; (5) a pulling down of the recto-vaginal septum; (6) anomalies, as congenital dilatation of the colon, or congenital strictures; (7) lead poisoning; (8) hernia; (9) peritonitis; (10) displacement of the right kidney, obstructing the lumen of the duodenum; (11) spasm of the pylorus, or the muscles of the intestine, as in hysteria and neurasthenia; (12) diseases of the secretive organs and intestinal tract, including chronic affections of the liver, stomach, intestines, enteritis, colitis, and fissure of the anus; and (13) venous obstruction which causes hypertrophy of the mucous and submucous coats and impairs peristalsis. (14) A very important cause is the formation of a "pouch, changing the direction of the inter-abdominal rectal pressure to that of the vaginal, at right angles to it, and making it difficult for the rectal sphincters to relax and void the contents of the bowels." Another classification of causes includes dryness of the feces, and

differences in the functional activity of muscles and motor nerve apparatus in the intestines.

Regarding the causes of atonic and spastic constipation Reed* states that "Glenard considered displacements of the stomach and intestines as chiefly responsible, while Emminghaus traces habitual constipation to degenerative changes in the splanchnics, and Dunin thinks it attributable mainly to central functional anomalies in the nervous system. Boas finds it difficult either to deny or confirm these theories, but points out that in any fully developed case of neurasthenia, with constipation, there is likely to be found a vicious circle."

Defecation may be either voluntary or involuntary, the beginning and end of the act being voluntary, while the remaining part of the act is involuntary. An accumulation of feces and gases presses or stretches the fibres and induces peristalsis. The sphincter is contracted tonically during the intervals between defecation. *The defecation centers* are thought by Schäfer to be under the control of the sacral nerves, but others think the lumbar nerves govern defecation. Reed locates the center at the second segment of the lumbar part of the spinal cord, at 9th, 10th or 11th dorsal vertebra. *The sphincter* is also influenced by a cerebral center located, it is supposed, in the optic thalmus. When the feces and gases pass from the sigmoid, they stimulate the rectal mechanism, and an impulse to evacuation is induced. According to Kirke, "the stimulus, however produced, is transmitted to the center in the cord through the hemorrhoidal and inferior mesenteric plexus, and is then reflected to the muscles of the rectum through

* Reed. Diseases of the Stomach and Intestines, page 767.

the pudendal plexus, resulting in a relaxation of the sphincter, a contraction of the muscular gut walls, and expulsion of the feces."

By compression of the abdominal viscera, the feces are aided in their downward course, when they reach the uppermost Houston valve on the left wall they may rest there, or be pressed onward to the next lower valve on the right anterior wall. The feces thus gradually approach the anus, during which time the levator ani muscles "draw the canal upward and over them." The levator ani not only thus raise a part of the pelvic floor but prevent distension of the pelvic fascia. Hyrtl says that "the levatores ani are related to the anus like two cords of a tobacco pouch." It is thought that an inhibitory seat in the brain in the optic thalmi allows the fecal mass to pass through the anus without causing it to close reflexly.

The amount of feces normally passed in twenty-four hours should be about five ounces and should consist of about seventy-five per cent. water, which depends, according to Landois and Stirling, partly upon the food and partly on the "energy of the peristalsis." When the peristalsis is very energetic, the feces are more watery, because the fluid from the food does not have time to be absorbed. They state also that "the quantity of water taken has no effect upon the amount of water in the feces." It is thought by O'Beirne that when the desire to go to stool is unheeded that the feces go back to the sigmoid by means of a "reverse peristalsis," but Gant states that his experience is that it is only exceptionally that the feces are returned to the sigmoid. "In most instances digital examination revealed an accumula-

tion of feces in the rectum. In a few the earlier examination revealed a like condition, while those made later showed the rectum to be empty." "Again, the lower rectum may be found empty, but proctoscopic examination will reveal the feces above and unsupported by the valves, moreover, if the entire fecal mass is not discharged at stool, the remaining portion may sometimes be seen above the valves."

HABIT is a matter of great importance, either as a prevention or cause of constipation—sedentary habits, improper diet, too rapid eating, irregular time for eating and going to stool, the use of cathartics, and failure to drink enough water are the most common to be noted.

Considered from a mechano-therapeutic viewpoint, Cyriax,* when considering chronic constipation, claims that "three features are apparent:

"1. Diminution in the expulsive power of the intestine.

"2. Diminution in the function of abdominal sympathetic.

"3. Diminution in the power and tone of the muscles of the abdominal wall."

THE INTESTINES RECEIVE THEIR NERVE SUPPLY as follows:†

"1. The cranial nerve (the pneumogastric). (Sajous believes that the 'vagal system probably alone excites and regulates intestinal functions during digestion as well as during intervals).'

"2. The spinal nerves especially those entering at the distal and proximal bowel segment.

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* Cyriax. Mechano-Therapeutics in the Treatment of Chronic Constipation. *British Medical Journal,* Oct. 8, 1910.

† Byron Robinson. The Abdominal and Pelvic Brain, page 318.

"3. The sympathetic system."

The sympathetic nerve supply includes:

(a) Billroth Meissner plexus "supplying glandular structure and has to do with secretion.

(b) Auerbach plexus supplying muscles.

(c) Solar plexus.

(d) Lateral chain of sympathetic ganglia on each side of the vertebral column from which arise the great splanchnic nerves."

He stated that the sympathetic nerve causes the periodic movement, rhythmic in character. Pflüger noted that if, the splanchnics were stimulated the movements of the bowels were prohibited, "the bowels become pale and the blood vessels anemic." The splanchnic supplies motor and vaso-motor nerves to the blood vessels of the intestine and also sensory fibres.

THE SMALL INTESTINE (Arnold* and Reed†) receives its vaso-constrictor neural cells from the 6th dorsal to the 2nd lumbar segment, and its vaso-dilator neural cells in the nucleus of the 10th cranial nerve.

Inhibition of the action of the small intestine is stated by Arnold to be chiefly in the spinal cord segments corresponding to the vaso-constrictor neural cells supplying the part. He states that probably there are some inhibitory paths in the 10th cranial and some accelerators in the cord. The same author believed that the accelerating cells for the small intestine were "chiefly in the nucleus of the 10th and possibly of the 11th cranial nerve."

If the vagus is stimulated "the movements of the

*Arnold. Examination of the Back. *Medical News,* March 18, 1905.

† Reed. Diseases of the Stomach and Intestines, page 52.

small intestines are increased" (Braam Houckgeest). Landois and Stirling* state, however, that the inhibitory nerve of the small intestine is the splanchnic while the capillaries contain arterial blood. When this changes the splanchnics are stimulated and peristalsis is increased.

THE LARGE INTESTINE receives its vaso-constrictor neural cells† from the 11th dorsal to the 2nd lumbar segments, probably the vaso-dilator† neural cells for the first half of the large intestine are in the nucleus of the 10th cranial nerve. The accelerating cells for the ascending part of the large intestine are probably found in the nucleus of the tenth and possibly in the eleventh cranial nerves. Arnold believed that the inhibitory neural cells of same correspond to its vaso-constrictor neural supply, and that probably the tenth may contain inhibition paths and that some accelerators may be found in the cord.

Reed‡ says that the colon is innervated partly by the sympathetic and partly from the lower spinal nerves. He says that the vaso-constrictors are from between the 6th dorsal and 2nd lumbar segments, and that the vaso-dilators are from the same part and from the pneumogastrics. Landois|| states, that the lumar branches of the sympathetic "contain inhibitory fibres for the descending colon and rectum."

Reed states, that the vaso-constrictors of the *sigmoid flexure and rectum* are from the 10th dorsal to the 4th lumbar segments and that, the vaso-dilators

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* Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 289.

† Arnold. Examination of the Back. *Medical News*, March 18, 1905.

‡ Reed. Diseases of the Stomach and Intestines, page 61.

|| Landois. Text-Book of Human Physiology, page 720.

are from between the 1st and 4th sacral segments. It should be noted that the vaso-constrictors of the genital organs come from the lumbar nerve roots and their vaso-dilators from the sacral nerve roots.

The neural cells (Arnold) for the *external sphincter* are "probably in the last sacral and to some extent in the coccygeal segments."

If the nervi-erigentes, partly formed by fibres that leave the cord in the sacral nerves (2nd to 4th),* be stimulated, contraction of the longitudinal rectal fibres occurs, and the action of the circular fibres is inhibited, even when the hypo-gastric nerves are stimulated by which they are supplied and whose stimulation has "an inhibitory effect on the longitudinal muscles" (Fellner).

Many measures and methods have been employed in the treatment of constipation, among the most satisfactory have been dietary, exercise, electrical, and mechanical means. Each has its particular field.

In the treatment of constipation due regard should be paid to causes, as they determine the initial step in the treatment. Atonic conditions with relaxed abdominal walls may require systematic adapted exercises, and in cases of the aged or weak, or those who cannot or will not exercise a proper abdominal support is necessary. Irregular habits of going to stool demand regularity. As habit has a marked influence over constipation it is essential that the patient be trained to elect a particular time for going to stool, and sit for twenty minutes if necessary always abstaining from exertion or straining. If the desire comes on during the day ignore it if possible until the next day at the *stated* period and thus

* Howell. Text-Book of Physiology, page 706.

begin to establish a regularity. Fibroid tumors require the use of the X-ray every other day for ten minutes until a dermatitis occurs. A rest should ensue until the disappearance of the dermatitis when a second series of rayings should follow. A hot douche within and a cold cloth over the surface when raying may prevent dermatitis (Nagelschmidt). Spasms of the pylorus require a restricted diet and treatment from the 50 candle power incandescent lamp. Diseases of the secretive organs and intestinal tract demand special treatment suited to the case in question. Dryness of the feces calls for the use of agar-agar and the copious drinking of water.

The diet should in all cases be strictly regulated, and restricted to foods calculated to assist peristalsis and of a character that the residue will be sufficient in quantity, and of a non-intoxicating nature not disposed to ferment. Zoolak, milk, koumiss, toasted bread, unsweetened zwiebach and cooked fruits are an effective and acceptable diet. A more liberal diet includes in many cases a diet of triscuit, shredded wheat biscuit, cracked wheat, oatmeal, farina, unsweetened zwiebach, home made graham bread (a day old), carrots, white turnips, spinach, lettuce, string beans, celery, stewed fruits,—plums, peaches, or pears with thin syrup, fresh apples, or grape fruit,—nuts except almonds (unless blanched) and soups not made from meat stock. Agar-agar owing to its affinity for water makes the stools softer. It may be soaked in milk and eaten, or boiled like oatmeal with a few figs or other fruit to flavor it. The equivalent of a few teaspoonfuls of the dried agar-agar is sufficient daily for a child. An adult dose may even be half a cupful, measured dry. A

small baked sweet or white potato with the jacket on, to be thoroughly masticated, is allowed occasionally. Hot water at meals and a copious drinking of water daily, is employed on general principles. Flesh, fish, fowl, oysters, shell fish and eggs are usually prohibited. Food should in all cases be *thoroughly* masticated. Exercises advocated by Dr. Watson L. Savage and others are the liver squeeze; flexion of the knees on the chest; describing a circle with the feet, legs in apposition, and knees not flexed; and other movements executed with the patient lying upon a hard surface or table, and untrammeled by corsets, skirts or other clothing. They are useful adjuncts in some obstinate cases. These exercises should be done before breakfast, after drinking freely of water.

Among mechanical means, the Taylor and Zander machines were the forerunners of the mechanical method of to-day. They were followed by the use of the oscillator which gives a general vibratory treatment—a passive exercise of the body and the abdomen in particular. Such treatment has proved very efficacious in the hands of some operators by applying the belt to lumbar spine, to the side, over the liver, and to the abdomen. The first treatment being from three to five and seven minutes, the stroke being at first six millimeters, and later increased to ten; with the motor speed adjusted to the patient's sense of greatest efficiency which is usually at the highest rate. This treatment is continued as a rule for about twenty-six days. Selective, harmonic electric vibration is also a favored measure used by Dr. Morris W. Brinkmann.

The treatment of constipation by mechanical vibration calls for attention to a few details. (1) It is essential that the bladder be emptied before the treatment is begun. (2) If the skin is sticky, owing to excessive perspiration, dust the surface over the abdomen with talcum powder. (3) The application of heat, dry or moist, to a hypersensitive abdomen, before vibratory treatment will make the surface less sensitive. (4) A high enema of warm water and soap-suds or a saline enema preceding the local vibratory treatment is essential as a routine in obstinate cases of constipation. (5) Relaxed abdominal muscles necessitating particular attention to position, are a requisite.

The patient should be properly prepared. The administrations can be made directly to the skin or over the undervest. It is a waste of time and the unnecessary expenditure of much energy on the part of the physician to attempt in any case to vibrate over other clothing than an under garment.

The general vibratory treatment which should be instituted on the first day of treatment consists of spinal stimulation followed by an abdominal massage, and in most cases an internal rectal vibratory treatment. Vibratory treatment of the liver and spleen is usually indicated. The treatment should be thorough and given systematically with regard to technique. The vibrations should be mild at first, then gradually increased in pressure depending on the density of the part and the conditions present. The system of bridging the condition of relief from treatment to treatment, lessening the frequency as the requirements permit, is to be followed.

Moderate pressure is recommended to be applied

between the transverse processes on each side of the spine. Tolerance to pressure increases during an administration and during the course of the treatment. Pressure should be light at first, being gradually increased. Too heavy pressure, especially when prolonged, inhibits, and may cause nausea and weariness. Sensitiveness to impression is only an approximate measure of irritability, for, as Luderitz found, the motor nerve fibres are paralyzed sooner than the sensory by continuous pressure, which should be taken into consideration.

The treatment should be administered with care to avoid the production of contractions or pain. During the external treatment pressure should be graduated in order to avoid the induction of unpleasant effects. It is advisable always to begin the treatment by vibrating the spinal nerves, using a small ball vibratode, employing a medium stroke, and moderate pressure on each side of the spine, alternately from above downward, to elicit points of tenderness. The sensitive sites should be given slightly prolonged interrupted vibration. Otherwise the spinal vibration should be limited to the nerves whose centers are involved in the case under treatment. It is thought that the treatment of opposite sides alternately intensifies the effect on nerve centers.

Divulsion of the sphincter is necessary in some cases. This may be accomplished by mechanical vibration. A pyramidal vibratode is employed, with fairly rapid speed, and full stroke, for five minutes daily. The vibratode should be gradually introduced. As the tissues relax it can be gradually worked inward.

Abdominal vibration has a curative effect on constipation, assists digestion by increasing the functional activity of the pancreas, liver and stomach, promotes muscular nutrition, increases absorption, and renal elimination, strengthens the muscles of the abdomen, and increases nervous and circulatory activity, and slows the pulse rate.

In treating the abdomen, apply compressing or deep vibratory friction, employing a flat disc vibratode, using a medium stroke for the purpose of relieving intestinal stasis and to assist in dislodging feces, as well as to stimulate the vascular system.

It is always preferable, as there is apt to be a quantity of feces present, to treat the lower part of the bowel as the first step in the treatment. In that event, commence on the left side a short distance from the sigmoid. Use vibratory friction downward and inward six or seven times, gradually beginning higher up, finally proceeding from beneath the ribs downward and inward to the point of termination. Then vibrate the transverse colon, working from left to right, gradually lengthening the line of advance as you approach and pass the median line. Then begin a little below the hepatic flexure and apply vibratory friction in the same manner as in the preceding description, using deep pressure and moving upward six or seven times, gradually lengthening the line of advance. Extend the vibration lower and lower until the caecum has been thoroughly vibrated. Finish by a deep circular friction from right to left, moving over the surface ten or twelve times, repeating the operation if deemed necessary like cannon ball massage, using a ball vibratode or the cap shield of some vibrators. The speed should

be slow, because parts containing unstriped fibres after being stimulated react "for a long time after the stimulus is withdrawn."

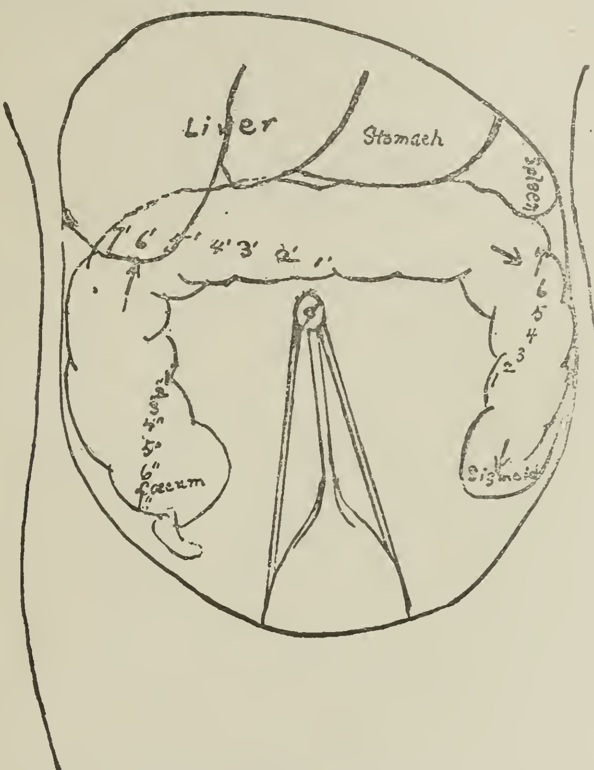

Fig. 57.—Diagrammatic illustration of abdominal vibration. The figures show the starting place and the arrows the end of each line of advance. The first line is from one to the sigmoid, and the last from the cæcum to the transverse colon. The treatment is finished by an abdominal vibratory massage with a ball vibratode, or cap shield of some machines, from the cæcum to the sigmoid like cannon-ball massage.

In a Thiry-Velly fistula, Fubini estimated the rate of motion of a smooth sphere of sealing-wax along the intestine. It took 55 seconds to travel 1 cm. (2-5 of an inch). An induction current greatly increased the motion, to 1 cm. in 10 seconds.

Landois and Stirling state that "the strong peris-

talsis which precedes defecation, can be aided, and to a certain degree excited, by rapid voluntary movements of the external sphincter and levator ani, whereby the *plexus myentericus* of the large intestine is stimulated mechanically, thus causing lively peristaltic movements in the large intestine." These movements may also be excited by the action of mechanical vibration by the employment of an internal rectal vibratode which procedure should follow the abdominal vibration.

When administering an INTERNAL RECTAL VIBRATORY TREATMENT the rectal vibratode should be well lubricated and introduced while in motion to avoid shock. Great care must be taken, however, not to overstimulate the intestine; lest dysperistalsis be induced. For "all stimuli applied to the plexus myentericus increase the peristalsis which may become so very violent as to cause evacuation of the contents of the large intestine, and may even produce spasmodic contractions of the musculature of the intestines." The administration should be from three to five minutes, using a short stroke, and a rate of speed which will give the maximum width to the loops that are formed by the vibration of the vibratode. In some cases, the first treatment is made slightly shorter. In using the short rectal vibratode have the patient lie with his back toward the machine, and knees flexed. In many cases, the treatment is more easily given when the patient is in the knee-chest position. In very obstinate cases a flexible rubber vibratode, twelve to fifteen inches long, is of service, it being introduced while the patient is in the knee-chest position. Duration of this treatment should be about three minutes, a moderate rate of speed and full stroke being em-

ployed. If the stimulus be strong and long continued, overstimulation and exhaustion, otherwise termed "intestinal paresis," takes place, that is, "continued congestion of the intestinal blood vessels ultimately causes intestinal paralysis."

In chronic cases, and when impaction is present, copious high injections of warm water are advisable, at first daily. Care should be taken that these injections be properly administered, which under no conditions should be left to the patient, as in most cases it will be improperly done. A special vibrating colon tube from eighteen to twenty-four inches in length should be employed. Not more than one, or one and one-half quarts of quite warm water are generally necessary, and it should be retained as long as conveniently possible, a saline solution of one quart 110° F, twice a week being advisable in some cases. Such enemas increase the fluidity of the blood and assist the elimination of "pathogenic toxic" wastes. With the patient in the knee-chest position, and the rectal vibratode, well vaselined, inserted in the cap shield and connected to the douche tank, start the vibrations and allow some of the water to flow, to carry the air out of the tube. Then slowly insert the tube while it is vibrating. Allow the vibrations to continue while the first quart or half quart flows, then stop the vibrations while part of the remainder flows. While the last part flows, continue the vibrations. The following day an oil enema, 20 tablespoonfuls or a cupful if sufficient, of warm olive oil are given in the same manner to soften adherent masses. This enema is usually retained for twelve hours, when but a cupful is used. Water and oil enemas are given alternately until no hard scyballa appear in the

movements. Rectal vibratory treatment may be indicated in connection with the external treatment for the purpose of toning up the bowels or to overcome spasmodic strictures. When soap is mixed with the water enema, green soap or soft soap is to be preferred, as, according to Bolton, irritating rashes may appear "on the day following the injection" when hard soap is used. He makes this statement from results from observation of 903 enemata.

Vibratory treatment of constipation should be administered daily until the bowels move regularly, after which, for a time on alternate days, gradually lessening the frequency as the bowels become normal. The majority of these cases are practically cured in a few weeks' time. A retroverted uterus which complicates the condition will require treatment. The static wave current per rectum for twenty minutes every day for a month during an intra-menstrual period and every other day the following month, will in most cases remove this obstacle unless adhesions are present.

Mechanical vibration in conjunction with a regulated diet together with systematic exercise, when indicated, is the treatment *par excellence* for constipation. When carefully administered, mechanical vibration is absolutely painless, harmless, and productive of the most gratifying results.

Contra indications for vibratory treatment are the presence of ulcer, cancer, hemorrhage, acute inflammations or febrile states.

In the treatment of mucous colitis as Koehler* has so well said it is best:

* Geo. F. Koehler, M. D. Some Remarks on the Signs, Symptoms and Treatment of Mucous Colitis. *Medical Sentinel.*

"1st. To eliminate as far as possible any known cause.

"2nd. To use the best possible means of overcoming stasis of the bowel, and procure, if possible, normal evacuations of the contents.

"3rd. To use necessary means to restore and improve the natural tone of the mucous membrane and muscular coats of the intestines."

Mucous colitis responds favorably to a daily vibratory treatment of the abdomen when employed in conjunction with a modified Van Noorden's diet,* which follows, together with exposure to the X-ray over the abdomen for ten minutes every other day

Fig. 58.—Rectal vibratode for flushing, with special fitting for attachment to the vibrator and to a douche can.

(one milliampere at 14 inches or an equivalent), until a reaction occurs, and the wearing of a proper abdominal support either a corset or abdominal supporter. Mechanical vibration to the spine, liver, stomach and spleen are indicated if there is constipation. Oil enemas, 20 tablespoonfuls of warm oil (pure olive oil, owing to deleterious effects of an acid in cotton seed oil) may be injected through the rectal vibratode (see Fig. 58). These are of the utmost importance. Daily hot baths of very *short* duration or a cold sponge, when followed by prompt reaction, and outdoor life are essentials.

* Van Noorden. Mucous Colitis.

Modified Van Noorden Diet

In the morning in bed at seven o'clock.—Three-tenths of a quart of milk and cream (two parts of milk and one part of thick sweet cream); then, usually, a rub with moderately cold water.

At eight o'clock.—One-half pint of Kissengen water. It can be made from Kissengen tablets.

At nine o'clock.—Three-tenths of a quart of the the above milk-cream mixture or of thin tea or coffee with much cream; sometimes, also cocoa prepared with cream. In addition one slice of coarse bread, with butter.

At eleven o'clock.—Soup made from leguminous plants; in addition whole wheat bread with plenty of butter. Also a glass of Kissengen water.

At one o'clock.—Some meat dish (the author prefers none if indican present in urine). In addition vegetables of different kinds (except onions, cabbage, or turnips), boiled or baked potato with butter. Fruit with coarse skins and large seeds, as currants, gooseberries, cranberries, boiled, or a pound of grapes. One glass of Kissengen water. After eating rest in bed for an hour and a half with hot applications to the abdomen.

At four o'clock.—A light lunch similar to the breakfast, at nine o'clock. Then a walk of one and one-half to two hours.

At seven o'clock.—Supper like the dinner; sometimes, also junket or fruit-soup. In addition a slice of graham bread or zwiebach, unsweetened, with plenty of butter.

At nine o'clock.—Three-tenths of a quart of the milk-cream mixture as in the morning.

PLATE XII.—Application of Abdominal Vibration.

This diet must be continued for some time, 6 months or a year in some cases.

FLATULENCE* may arise from:

"1. Fermentation. Food may undergo acid fermentation (lactic, butyric) or alcoholic fermentation.

"2. Putrefaction. Albuminous substances may undergo decomposition.

"3. Alimentary. Certain articles of food and drink produce flatulency as cabbage, beans, peas, carbonated waters, etc.

"4. Intestinal respiration. Flatulence due to exchange of gas (CO_2 & N) between the blood and the contents of the stomach and intestines.

"5. Aerophagia, or swallowing of air may cause flatulence.

Flatulence may cause palpitation, distress, shortness of breath, irregular movements and pain, often supposed to be heart disease."

Abdominal vibration in connection with the regulation of general hygiene, diet, and in some cases the use of a proper abdominal support, are indicated. Spinal vibration applied at the exit of the 6th, 7th and 8th dorsal nerves on the left side of the spine sometimes causes eructation of gases. The ball vibratode is used here as always for applying spinal vibration. Aerophagia calls for special treatment,† as an abdominal support and correction of habit.

REFLEXLY THE INTESTINES MAY BE CONTRACTED (Abrams) by vibrating between the 1st and 2nd and 2nd and 3rd lumbar vertebrae. It is indicated in

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*Aerophagia & Flatulence. C. O. Spivak, M. D., *Medical Record*, April 29, 1905.

† Ibid.

the treatment of *atonic constipation.* Abrams believes that the circular fibres may thus be made tonic.

THE INTESTINAL REFLEX OF DILATATION (Abrams) can be elicited by concussion or vibration of the spine of the 11th dorsal vertebra. He recommends its induction in the treatment of spastic constipation. He believes that it tones up the longitudinal fibres.

VIBRATORY TREATMENT OF THE RECTUM with the rectal vibratode for five minutes, will tone up the parts and relax spasm of the sphincters.. Spinal vibration may or may not be necessary. Apply prolonged rectal vibration for inhibition. Tenderness of the 4th sacral nerve Cyriax* noted as often present in rectal affections.

IN THE TREATMENT OF DIARRHOEA colonic flushings —vibratory or otherwise—are indicated followed by a leucodescent light treatment for sedation. If dilatation of the stomach be present, causing retention of food, then the stomach reflex of contraction should be induced. The author has employed mechanical vibration between the 10th and 11th dorsal alternately with that between the 1st and 2nd and 2nd and 3rd lumbar vertebrae successfully.

Chronic diarrhoea is sometimes due to irritation caused by the presence of retained feces. In these cases a high enema should be employed and may be followed with rectal vibratory treatment or static electricity in the form of the rectal administration of the wave current to tone up the parts. Abrams employs concussion alternately on the spines of the first three lumbar and the 11th dorsal vertebrae.

THE KIDNEY "lies on the quadratus lumborum and psoas muscles opposite the two lower dorsal and two

* Cyriax. The Elements of Kellgren's Manual Treatment, page 165.

upper lumbar spines;" the right about 3/4 of an inch lower than the left. The upper border is on about a level with the space between the 11th and 12th dorsal spines, the lower border being as low as the third lumbar spine. "It is accessible to pressure just below the last rib, on the outer edge of the erector spinæ."

The nerve supply of the kidney is from the "renal plexus, which is formed by branches from the solar plexus, the lower and outer part of the semilunar ganglion, and from the lesser and smallest splanchnic nerves." The vaso-motor fibres come from the spinal cord mostly in the 10th to 13th thoracic spinal nerves (dog), and are likely affected by reflex stimulation. "The vagus† innervates the intrinsic unstriated musculature of the kidney."

Cl. Bernard and Eckhard|| claim that *stimulation of the splanchnic,* whose "renal vaso-motor fibres, which, in part at least, leave the spinal cord at the *first* dorsal nerve and pass into the sympathetic nerve," causes less urine. Section of the renal nerves causes polyuria "increased by stimulation of the spinal cord below the medulla oblongata as the contraction of the blood vessels throughout the body, still further raises the blood pressure within the glomeruli." Irritation of the cervical sympathetic lessens the secretion.† The vaso-constrictor nerves respond to electrical stimulation when rapid and of short duration. Stimulation of these causes a "shrinkage in volume of the whole organ."‡ "Stimu-

† Landois. Text-Book of Human Physiology, page 516.

|| Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 545.

‡ Howell. Text-Book of Physiology, page 811.

lation* of the peripheral end of the renal nerves also causes a diminution in the volume of the kidney." "Vaso-dilator fibres are best excited by slow rhythmical stimulation (2-5 shocks per second)." According to Bradford* the vaso-dilators of the kidney come from the 11th, 12th and 13th dorsal (dog) which when stimulated increase the functional activity of the organ.

If the KIDNEY IS DISPLACED Kellogg's method of replacement is as follows: After making movements to replace the stomach and bowels, the operator proceeds as follows for the right kidney. (The same is true for the left kidney and spleen, only "the fingers of the right hand" are placed behind). "Standing upon the right side of the patient the fingers of the left hand are placed behind, while those of the right hand are placed upon the abdomen; and by movements of the two hands the location of the kidneys is determined. While gently pressing the kidneys upward, the patient is asked to take repeated deep breaths. With each exhalation an effort is made to press the kidney up under the ribs of the right side by gentle pressure. As it moves upward and approaches its position, the right hand is shut and the closed fist is made to follow the kidney and hold it in position while the patient takes a number of deep respirations." This should be followed by abdominal vibratory friction for toning the relaxed abdominal muscles and also to increase the elimination of urine by accelerating the function of the kidneys and thereby increase the excretion of "waste products, chiefly nitrogenous bodies and salts," the

* Howell. Text-Book of Physiology, page 811.

excretion of water and perhaps even the reabsorption of "water from the uriniferous tubules."

The *amount* of urine secreted depends *upon the differences of pressure* between the blood in the glomeruli and the pressure within the renal tubules. "The secretion depends partly on the blood pressure as in (1) Increase* of the total contents of the vascular system so as to increase the blood pressure (2) Diminution of the capacity of the vascular system, provided the pressure within the renal area be thereby increased," which latter may be caused by stimulation of the vaso-motor center, "(3) Increased action of the heart." (4) The fullness of the renal artery governs the rise or fall of urinary secretion. The blood's composition also affects it slightly.

MECHANICAL VIBRATION MAY BE APPLIED TO THE KIDNEYS as follows: With the disc vibratode apply interrupted vibration or frictions over the kidneys. The 10th, 11th and 12th dorsal nerves may be vibrated at their exits with the ball vibratode to stimulate the renal plexus. If vibrated anteriorly, frictions are given, from without inwards beginning three inches above and three inches external to the navel after Cyriax's method.

THE KIDNEY REFLEX OF CONTRACTION† is induced according to Abrams by concussion of the spine of the 12th dorsal or 7th cervical vertebra. Vibration may be likewise applied.

THE KIDNEY REFLEX OF DILATATION (Abrams) is elicited by vibrating with the ball vibratode between the 6th and 7th and 7th and 8th dorsal vertebrae, or

* Landois and Stirling. Text-Book of Human Physiology, 4th ed., page 536.

† Abrams. Spondylotherapy, page 360.

the 10th dorsal spine. In diseases of the kidneys the 10th, 11th and 12th dorsal nerves are tender.*

Mechanical vibration may also be employed to relieve *oedema* when present in cases of renal trouble; the effect, however, is only palliative. In certain conditions, especially inflammation of the kidneys, it must be applied with the utmost caution.

THE BLADDER receives its vaso-constrictor neural cells chiefly from the 11th dorsal to the 2nd lumbar segments probably occasionally from the 3rd and 4th lumbar segments, and its vaso-dilator cells from the 3rd and 4th sacral segments (Arnold). Inhibition of its muscular coat with contraction of the sphincter of the bladder can be aroused in the 2nd, 3rd and 4th lumbar segments and the opposite effects in the 2nd, 3rd and 4th sacral segments (Arnold).

INCONTINENCE is sometimes cured by applications of supra-pubic mechanical vibration with the disc vibratode which may be applied either by the interrupted or frictional method. Spinal vibration may also be applied with the ball vibratode as indicated. "Kellgren† found that vibrating or shaking over the bladder has the extraordinary effect of relieving cough and rendering respiration freer. Sympathetic nerves over the bladder† are affected by vibrations or shakings in an upward direction just over the symphysis pubis about an inch from the middle line. This often leads to an immediate desire on the part of the patient for micturition; in some cases a rush of blood to the head also ensues."

THE BLADDER REFLEX OF CONTRACTION can be

* Cyriax. The Elements of Kellgren's Manual Treatment, page 165.
† Ibid., page 168.

elicited, states Abrams* "with one electrode over the sacrum and the interrupting electrode at the spine of the 5th lumbar vertebra." In disease of the bladder the sacral nerves particularly the 1st and 3rd are found† sensitive when the vibratode is applied to the nerve origins.

MORPHINE HABIT AND ALCOHOLISM and other drug habits in connection with moral restraints may be benefited by mechanical vibration, either by employing Dr. Pilgrim's method of "mesenteric flushing" as described in Chapter III, or by administering the abdominal and intestinal treatment described in the preceding pages. *For the insomnia* and restlessness, give a vibratory treatment to relieve the causes.

IN THE COCAIN HABIT peripheral circulation must be strengthened, and in *alcoholism* the vibration must be directed to the strengthening of the feeble heart as well. (See chapter on Circulation.)

THE APPLICATION OF MECHANICAL VIBRATION TO THE TREATMENT OF THE PELVIC ORGANS is indicated for the relaxation of contracted muscles which should be treated as muscular contractions elsewhere. Applications may also be made to the other organs and structures including the rectum, the vagina, uterus, ovaries of the female, and male genital organs as indicated for purpose of sedation or stimulation.

THE PELVIC PLEXUS supplying the rectum, bladder, prostate, vagina and uterus, according to Gray, is formed "by branches from the 2nd, 3rd, and 4th sacral nerves and by a few filaments from the first two sacral ganglia."

The vaso-dilator neural cells for the uterus and

* Abrams. Spondylotherapy, page 359.

† Cyriax. Elements of Kellgren's Manual Treatment, page 165.

ovaries are chiefly in the 3rd, 4th and 5th sacral segments,* and the vaso-constrictor cells for the same organs are chiefly from the 11th dorsal to the 2nd lumbar segment, probably occasionally from the 3rd and 4th lumbar segments. Arnold stated that inhibitory cells of the muscular coat of the Fallopian tubes and uterus with those which contract the cervix, vagina and perineum are chiefly in the 2nd, 3rd and 4th lumbar segments, and that the neural cells for contraction of the Fallopian tubes and the muscular coat of uterus with dilatation of cervix, vagina and perineum are in the 2nd, 3rd and 4th sacral segments.

THE MOTOR FIBRES OF THE UTERUS are supplied "from the sympathetic chain,—chiefly from the fourth to the sixth lumbar ganglia." (Landois and Stirling.) If the hypo-gastric plexus, whose fibres come from the "last dorsal and upper 3 or 4 lumbar nerves, run into the sympathetic and then reach the hypo-gastric plexus" (Frankenhauser), be stimulated, uterine contraction is induced. If the nervi erigentes be stimulated, movement results (v. Basch and Hofman). The uterus may be made to contract reflexly by stimulating the central end of the sciatic.

Abrams states that REFLEX UTERINE CONTRACTION may be induced by stimulation over the spines of the first three lumbar vertebrae. Probably deep interrupted mechanical vibration between the 12th dorsal and 1st lumbar also between the 1st and 2nd lumbar, and between the 2nd and 3rd lumbar and between the 3rd and 4th lumbar vertebrae, the exits of the last dorsal and first three lumbar nerves, will produce the same effect.

*Arnold. Examination of the Back. *Medical News*, March 18, 1905.

Cyriax* observes that sometimes "supra-pubic uterine frictions, at the side of the symphysis pubis about two inches from the middle line will induce contraction of the uterus."

"Kumpf† found very strong uterine contractions to arise from a vibrator, and a less marked contraction from the use of manual vibrations. Lange also obtained a stimulating effect with his vibrator."

PROLAPSE OF THE UTERUS may be treated by "lifting up the protruding parts with simultaneous vibration" and interrupted vibration over the posterior sacral nerves and the subtrapezial plexus (found in the trapezius at a point in a line drawn from the middle of the clavicle backwards) as suggested by Cyriax.‡ He states that pelvic disease is sometimes associated with "chronic shoulder ache."

DISEASE OF THE GENITAL ORGANS is sometimes the cause of tenderness of the 12th dorsal, 5th lumbar, and 2nd to 4th sacral nerves. The 3rd sacral nerve is particularly sensitive in uterine inflammations or displacements.|| Interrupted vibrations are indicated over the site of tenderness.

MECHANICAL VIBRATORY TREATMENT of the pelvic organs is valuable in AMENORRHEA, DYSMENORRHEA, VAGANISMUS, NON-INFECTIOUS ENDOMETRITIS, METRITIS AND OÖPHORITIS, RECTAL ATONY, SOME PROSTATIC CONDITIONS AND COCCYGODINIA.

IN AMENORRHEA treatment is directed to increasing the metabolism due attention being given to diet, baths, outdoor life and hygiene in general. Locally

* Cyriax. Elements of Kellgren's Manual Treatment, page 235.

† Cyriax. Vibrations and Their Effects.

‡ Cyriax. Elements of Kellgren's Manual Treatment, page 160.

|| Cyriax. Elements of Kellgren's Manual Treatment, page 165.

a tonic spinal application is made externally with the ball vibratode and a vibratory treatment of the liver, spleen, stomach and abdomen with additional rectal supra-pubic and ovarian vibration is indicated.

Mechanical vibration is contra-indicated in pyosalpinx, tumors, and pelvic abscess.

Over the ovaries frictional or interrupted mechanical vibration may be applied with the disc vibratode two inches internal to and two inches below the anterior superior spine of the ilium downwards and inwards.

Mechanical vibratory treatment of the vagina may be employed in vaginismus, vibrating either per vagina or from the rectal site, using a vaginal or rectal vibratode. The vibratory treatment should be continued for five minutes or more. A very efficient method is the employment of a static current with the vaginal vacuum electrode for fifteen minutes daily.

The prostate and testicles have their vaso-constrictor supply from the 11th dorsal to the 2nd lumbar segment, probably occasionally in the 3rd and 4th lumbar segments. (Arnold.) The nerves of the prostate gland are from the hypo-gastric plexus. The testicles have vaso-dilator cells chiefly in the 3rd, 4th and 5th sacral segments. (Arnold.) The visceral afferent nerve fibres which supply the prostate are governed by the 10th, 11th, 12th thoracic and the 1st, 2nd, and 3rd sacral. The "motor nerves of the ischio-cavernosus and deep perineal muscles arise from the 3rd to the 4th sacral nerves."

Enlarged prostate and non-infectious prostatitis may be treated by the static current or mechanical vibration. When employing mechanical vibra-

tion introduce a rectal or other specially constructed soft rubber vibratode which has been previously well lubricated.

Insert the vibratode into the rectum while in motion. The application should be continued for from three to five minutes or longer, if so indicated. As with all intra-pelvic administrations the bladder and bowels should be evacuated before treatment. This method is of no avail in the treatment of chronic enlargement with hyperplasia. It "accelerates the function of the glandular epithelium," and causes a "more abundant afflux of blood, which favors filtration."

Schmidt believes that the cases of chronic prostatitis that are most benefited are "(1) where mental condition is influenced by prostatic results; (2) where there are small inflammatory foci; (3) isthmical inflammations combined with old infiltrations in the prostatic urethra; (4) simple sexual exhaustion." The treatment par excellence for this condition is the static wave current per rectum with a metal electrode for twenty minutes (Snow). X-ray is sometimes indicated.

Bubo following specific urethritis, has been reported as successfully treated by Dr. Fechner of New York, in which cases "application by deep pressure was made over the 8th and 12th dorsal and 5th lumbar spinal nerves, and to the inguinal glands."

In coccygeal, anterior or lateral, displacements, the contracted muscles about the part should be treated with local interrupted vibration with the disc vibratode. After which introduce the rectal vibratode into the rectum, the left hand being placed over the coccyx, the patient lying on her right side

with the knees drawn up. Apply prolonged vibration with suited pressure to relax the contracted parts in order that the coccyx may resume its normal position. Posterior displacement will require prolonged heavy vibration with the disc vibratode over the posterior surface of the coccyx. Care must be exercised not to apply too much force. If the parts are sensitive very light pressure should be used at first and the pressure should be gradually increased. The static wave current applied by means of a metal electrode fitted over the coccyx relieves tension and soreness. The brush discharge as well as vibration is excellent for removing the bruises as well as lessening the soreness.

In the treatment of pelvic conditions mechanical vibration can often be employed to advantage in connection with light, electricity, hydrotherapy, or exercise according to indications.

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